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Scientia non habet inimicum nisi ignorantem.

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STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
January 1914	621,902	29,851	651,753	2,768,470
February	597,545	28,716	626,261	2,660,186
March	657,708	29,093	686,801	2,917,346
April	655,607	28,270	683,877	2,904,924
May	689,259	30,970	720,229	3,059,340
June	688,232	29,694	717,926	3,049,558
July	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,588,075

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
June 30, 1913	188,094	9,060	14,654	211,808
July 31	170,242	9,403	13,378	193,023
August 31	158,223	9,236	13,172	180,631
September 30	152,637	9,361	12,321	174,319
October 31	148,882	9,377	12,712	170,971
November 30	147,569	9,286	12,680	169,535
December 31	150,012	9,516	11,811	171,339
January 31, 1914	154,202	9,471	11,979	175,652
February 28	157,673	9,508	12,266	179,447
March 31	162,815	9,619	13,390	185,824
April 30	165,005	9,625	14,150	188,780
May 31	165,433	9,619	14,284	189,336
June 30	166,248	9,442	13,256	188,946
July 31	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Cost per ton	Profit per ton	Total profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
January 1914	1,902,733	27 4	18 2	9 3	876,577
February	1,861,442	26 10	17 11	8 10	823,654
March	2,094,098	26 4	17 3	9 1	945,000
April	2,075,561	26 6	17 3	9 3	955,600
May	2,196,287	26 3	17 0	9 3	1,011,968
June	2,178,161	25 5	17 1	9 5	1,025,629
July	2,281,717	25 10	16 9	9 1	1,032,562
August	2,261,800	25 5	16 8	8 9	988,567
September	2,188,939	25 11	16 9	9 1	989,859
October	2,301,795	25 8	16 8	8 9	1,004,264

The above are the official statistics published by the Transvaal Chamber of Mines. They understate the cost by about 15% and overstate the profit by about 30%.

Gold Output of India.

Year 1912	Year 1913	Dec. 1914	Year 1914
£2,265,094	£2,299,315	£211,911	£2,340,259

Production of Gold in West Africa.

Year 1911	Year 1912	Year 1913	Nov. 1914	Year 1914
£1,069,442	£1,497,179	£1,634,700	£154,674	£1,579,345

Production of Gold in Rhodesia.

Year 1911	Year 1912	Year 1913	Nov. 1914	Year 1914
£2,647,894	£2,707,368	£2,903,267	£311,711	£3,270,638

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,448,332
January, 1914	9,762	102,261	112,023	475,840
February	8,493	94,812	103,305	438,809
March	1,173	91,446	92,619	393,418
April	8,774	90,233	99,007	420,553
May	7,138	99,068	106,206	451,132
June	1,725	99,290	101,015	429,081
July	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435,164
September	1,535	103,577	105,112	446,485
October	2,028	99,366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253

Other Australasian Gold Production.

	1912	1913	Nov. 1914	1914
	£	£	£	£
Victoria	2,039,400	1,847,400	118,000	1,563,900
Queensland	1,484,160	1,118,610	102,400	905,510
New South Wales	702,129	635,703	53,425*	425,615*
New Zealand exp't	1,345,115	1,345,131	12,876†	822,395†

*July figures only. †August figures only.

American Copper Producers' Association's Figures.
In Tons of 2240 lb.

	Production.	Deliveries			Stocks at end of month
		Domestic	Foreign	Total	
Total 1913	724,307	342,566	387,974	730,540	—
January 1914	58,826	21,409	39,266	60,675	38,933
February	54,715	21,244	37,455	58,699	34,949
March	65,023	31,184	39,983	71,167	28,805
April	67,634	28,315	36,761	65,076	31,363
May	63,530	24,818	32,460	57,278	37,615
June	63,101	20,637	32,745	53,382	47,334

No figures published since

The United States Customs report exports as follows: July 34,145 tons, August 19,676 tons, September 23,866 tons, October 28,995 tons, November 20,170 tons.

Nigerian Tin Production.
In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Nov., 1914 tons	Year 1914 tons
2,532	5,032	283	4,502

Production of Tin in Federated Malay States.
Estimated at 70% of concentrate shipped to smelters.

1911 tons	1912 tons	1913 tons	Nov., 1914 tons	Year 1914 tons
43,967	48,250	50,128	4,085	44,976

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
January to June, 1914	2862½	£263,387	£92 0 3
July 6	232	£19,416	£83 13 10
July 20	248	£20,394	£82 4 9
September 21	151½	£10,944	£72 4 10
October 5	204	£14,938	£73 4 6
October 19	257	£17,502	£68 2 0
November 2	238	£17,963	£75 9 6
November 16	251¼	£20,281	£80 14 5
November 30	265½	£22,687	£85 10 7
December 14	277¼	£24,925	£89 18 0
Year 1914	4987	£432,437	£86 14 3
January 4, 1915	328¾	£28,353	£86 4 11

Imports of Tin Concentrates at Liverpool.
Reported by H. A. Watson & Co.

	Bolivia tons	Nigeria tons	S. Africa tons
November—			
Concentrate	789	519	192
Metal Content	473	363	134
December—			
Concentrate	422	421	60
Metal Content	253	295	42

REVIEW·OF·MINING

INTRODUCTORY.—On December 23 it was announced officially that, by consent of the Treasury, the Stock Exchange would re-open for business, under severe restrictions, on January 4. Minimum prices are in force, no arbitrage business is allowed, all bargains must be for cash, and every bargain must be officially recorded. Several regulations are provided for preventing enemy-aliens from liquidating securities, and at the same time all naturalized members are required to prove that they have been denationalized in the country of their origin. While this is not a re-opening in the full sense, it is a re-opening of the quarters in which members are accustomed to meet and a provision of better facilities for such restricted business as has recently been transacted under conditions of great discomfort. It is another step toward normal conditions, and to that extent it is cheering. The similar steps taken at New York have been moderately successful. Until the conclusion of the war is measurably near, no unrestricted resumption of share-dealing is possible. Meanwhile, the restrictions placed on the business of the Exchange are tending to increase the proportion of dealings outside, particularly by banks, and as the elimination of the jobber is thereby effected, it tends to lessen the commission paid by the public. The placing of the War Loan through the Bank of England is a notable example of this procedure, which may exert a profound influence on financial developments.

Since this resumption, the limited business of the Exchange has increased steadily in volume as dealers have become familiar with the new conditions. Undoubtedly the re-opening has had an excellent effect in the City.

TRANSVAAL.—The output of gold in November was fully maintained, the slight decrease being due to the shorter month as compared with October. The supply of labour decreased also, to 166,039, but this is explained by the normal seasonal migration of the natives, accentuated by the recent good rains all over South Africa. Moreover, the unsettlement of mind caused by the war has not been without its effect. White labour also, to some degree, has suffered from the call to arms. This has involved temporary loss of technical efficiency, already rectified. The December production of £2,952,755 is slightly less than that of November, and brings the year's total to 8,378,139 ounces, worth £35,588,075, which is £3,000,000 below 1913. The labour figures for December were 164,650, a fall of 1400 on the month, and comparing with 150,012 a year ago.

Final figures are not yet available, but it appears that the total dividends paid by the mines of the Rand for 1914 is £8,070,732, as against £8,111,310 in 1913 and £7,998,790 in 1912. One company, the Geduld, joins the dividend-payers, but two, the May Consolidated and Randfontein Central, step out. The Central Mining group distributes £4,798,394, indicating the relative importance of the business established by Alfred Beit and Hermann Eckstein.

In spite of labour troubles, several mines

on the Rand have been able to record a decrease in working cost. This good result is due chiefly to the re-organization of underground haulage and hoisting, commenced three or four years ago. For instance, the cost per ton at the New Modderfontein during the months July to October has averaged 14s. 10d., as compared with 19s. 11d. during the year ended June 30, 1913. The formation of the Crown Mines company, as an amalgamation of several mines, was undertaken for the same purpose. These re-organizations, of course, have involved the expenditure of much capital, in the case of the New Modderfontein £550,000, but the results have fully justified the policy.

The Ferreira Deep report contains a reference, by the company's consulting engineer, Mr. Percy Cazalet, to the earth-tremors that have impeded operations underground. Owing to the subsidences following such tremors, it has become necessary to keep a force of men continually engaged in watching the ground enclosing the shafts, more particularly, but also the drifts and stopes. This has been done at an additional cost of 6d. to 7d. per ton to the normal expenditure. Where drifts show signs of crushing, it becomes necessary to remove rock-pillars, because these are apt to burst suddenly under the pressure, and to replace them with timber structures of varying kind. In the stopes, the best corrective is the 'pack' system, which corresponds to dry-walling in coal mines. These measures have proved adequate to protect the stopes, so that not a single heading has been lost during recent months.

The maiden dividend of the Geduld is a pleasing event. Of this extensive property only one-sixth has, as yet, been developed. Before the scope of operations can be proportionately increased, it will be necessary to provide a large sum in capital. That must wait for better days. Another gratifying dividend declaration is that of the Brakpan, which has increased the distribution for the second half-year, making the total 30% for 1914, as against 32½% for 1913. Although milling only began in June 1911, this company has now returned its capital of £750,000 to the shareholders.

Developments in the New Goch are improving, mainly owing to the intelligence of the present manager, Mr. George G. Holmes, who has ascertained that the Main Reef Leader is so close to the Main Reef as to render it economical to stope the two of them together. The improved position of the company has enabled it to give notice of the intention to redeem its debentures, representing £86,225. Earnings now are at the rate of £120,000 per annum.

Continued scarcity of labour is hampering the Crown Mines, the treatment of 190,000 tons monthly being in contrast with an estimated capacity of 240,000 tons. The average recovery of 26s. 6d., however, compares well with the estimated assay-value of 28s. 6d. per ton. Provision for redemption of debentures, together with a decreased profit for the year, has compelled a reduction in the dividend.

The dependence of large-scale mining on the supply of capital is illustrated by the position of the Daggafontein Gold Mining Co., which, as recorded last month in the letter from our Johannesburg correspondent, has cut the lode in its main shaft at 3580 feet and found 40 inches of 8 dwt. ore. But in order to bring the mine to the productive stage a further sum of £750,000 is required, on top of the £248,550 already spent on the shaft and the £49,396 spent on boring. Until financial conditions relax, this promising enterprise will have to mark time.

Despite unfavourable labour conditions the New Modderfontein did well last year and faces a brilliant future, as indicated by the chairman, Mr. Raymond W. Schumacher. The ore reserve at the end of June was esti-

mated at 6,334,500 tons averaging 8·4 dwt. or 35·28 shillings per ton. During the twelve months previous 1,990,400 tons of 9·2 dwt. ore was developed. The operating cost has been lowered from 19s. 11d. per ton in 1913 to 16s. 11d. in 1914, with a reduction in sorting from 7·3 to 4·9%. Since June the cost has fallen to 14s. 10d. per ton on 16% sorting. It is expected that the proportion of waste separated by sorting in future will range from 15 to 20%, with the intention of winning a maximum profit rather than recording a minimum cost per ton. The property covers 1301 claims, of which 1265 are ore-bearing. Of these 150 were exhausted at the end of June last, with an average yield of 31,940 tons per claim. Of the 1115 unexhausted claims, 205 cover the 6,334,500 tons of ore now in reserve, while 65 claims cover territory "not included in the payable reserves," that is, non-productive ground. Thus there remain 844 virgin claims.

RHODESIA.—The November output of gold was good, considering that it was the result of a short month's work, being higher than the June and September production. For November the Shamva showed a decrease of £4267, while the Eldorado made a spurt, increasing the output by £6929 worth of gold from the treatment of super-grade ore.

Mr. Julius Weil, chairman of the Cam & Motor company, has returned from Rhodesia and at the recent meeting reviewed the efforts to obtain metallurgical efficiency. It is hoped to complete the necessary alterations of the plant by February. Extraction in December improved to 76% as against 63% in June. The sale of half-interest in the Cam-Good Shepherd claims for £50,000 and the issue of £50,000 of debentures for cash liquidates a debt of £100,000, leaving £44,000 owing to the bank. In order to protect this indebtedness and to provide for the underwriting of the debentures, the Cam & Motor has given the London & Rhodesian company a call on 100,000 shares at par. We hope that these arrangements will carry this promising mine through all its present difficulties.

Inability to pay the debenture interest due on January 1 places the Tanganyika Concessions in a position of temporary embarrassment. Arrangements had been made with the Société Génerale de Belgique whereby the money necessary for this purpose was to be provided, but the incidence of the war prevents remittance to London. It is proposed to ask for a consent to postponement of the payments due on the £2,500,000 of debentures until six months after the declaration of peace. Part of the staff of the controlling company, the Union Minière, has been transferred from Brussels to London. The smelting operations in Katanga have been continued without interruption, two furnaces producing 3730 tons of copper from the date of the Declaration of War up to the end of November. The third furnace was started early in December, so that the total production is expected to be not much short of the 12,000 tons estimated by Mr. Robert Williams in July.

WEST AFRICA.—The November statistics show a decrease as against October, but this is due mainly to the shorter month. As compared with September the yield is maintained. Of the nine principal companies, the Abbontiakoon, Prestea, and Ashanti Goldfields contribute two-thirds of the total. In November the Abbontiakoon increased its production to the September level, while the Broomassie shows an equivalent decrease. The two dredging companies are not doing much just now.

At the Naraguta meeting the chairman, Mr. Frank N. Best, referred to the lack of considerate treatment by the colonial administration. We shall deal with the subject in our next issue. Mr. Best explained that the decrease in production during the last four months is due to the commandeering of natives

by the Government for military purposes and to the re-establishment of the old rate of pay (6d. per diem) for unskilled labour. Otherwise, prospects are good, as we are also informed on independent authority.

In 1914 the Rayfield produced 611 tons of 70% tin concentrate, as against an expectation of 720 tons. This is not bad, considering recent circumstances. The Delimi area is developing well. From the Top and Shen properties, as far as tested, 6354 tons of concentrate may be expected, according to Mr. J. M. Iles, the manager.

CANADA.—Our correspondent at Toronto sends an interesting letter, in which he refers to the ticklish question of nickel export.

The Canadian Mining Corporation, controlling the Cobalt Townsite, City of Cobalt, and Cobalt Lake mines in Ontario, is maintaining production fairly steadily, considering the difficulties created by the war, especially the low price of silver. A four-weekly output of 10,000 to 11,500 tons is being made for a profit ranging from £17,000 to £26,000. Developments from a winze in the City of Cobalt indicate good prospects in this property.

UNITED STATES.—We note Mr. John D. Ryan's opinion that preparations should be made for tremendous business activity at the conclusion of the war. The Amalgamated Copper Co., of which Mr. Ryan is president, is planning to spend over $1,000,000 in metallurgical improvements, to be carried out by Mr. E. P. Mathewson.

The American gold production in 1914 is officially given as $92,823,000, against $88,885,000 in 1913.

AUSTRALASIA.—Our Melbourne letter is delayed in transmission. We comment editorially on the effect of the war on the metal trade.

The annual report of the Mount Elliott is entirely in accord with the forecast appearing in these columns nearly a year ago. The ower price of copper has emphasized the declining vitality of the mine. Dividends have decreased from £202,837 in 1913 to £36,879 in 1914, each financial year ending on June 30. The reserve is given as 33,750 tons of 11% copper ore, as against 81,500 tons of similar ore a year previous. We ignore the 3% copper mineral, which cannot be treated profitably. These results are not due to poor management, as is testified by the Comte de Venancourt, who made an inspection recently. Mr. W. H. Corbould, the consulting engineer, strongly advised the absorption of the Queensland Exploration, Queensland Copper Freehold, and Mount Oxide properties. The first outcome of this recommendation is a subsidiary company called the Dobbin & Cloncurry Mines, now in course of development. The Mount Elliott company is unwatering the Great Australia mine at Cloncurry. Meanwhile the scheme to erect a central smelter has been killed by the Comte de Venancourt's report, his opinion being that money for such a purpose should come out of profits.

INDIA.—The exploration of the ground south of the Mysore mine, conducted by the Southern Extension Syndicate from the 2160, 2385, and 2635-ft. levels, has not yet revealed anything of value. The last report to hand mentions the disclosure of a vein 18 inches wide averaging 5 dwt. per ton, a stringer 6 inches wide assaying 1 to 4 dwt., and a fold 4 feet wide of varying content up to 7 dwt. The best find was on the 2385-ft. level where the lode for 148 feet averaged 3 feet in width assaying 12½ dwt., but unfortunately this did not continue. Apparently there is little prospect of finding any substantial orebody south of the McTaggart shoot of the Mysore mine. The improvement in Ribblesdale's section of the Mysore, mentioned two months ago, continues, and some excellent assays have been obtained recently. On the 14th level of the auxiliary shaft, and in two winzes below it, the ore-shoot is 5 feet wide and assays over 2 ounces per ton.

MEXICO.—We publish two particularly interesting letters from engineers resident in the City of Mexico. These letters give reliable testimony in regard to the good behaviour of Zapata's and Villa's followers. Francisco Villa is now regarded as the possible agent in restoring order to the distracted country. He has succeeded in pacifying northern Mexico and is not ambitious to be president, so that it is likely that a respectable chief executive will be supported by him, so long as he remains in command of the army. This is now the hope of those anxious to see the mineral industry restored to its former productivity.

Later information from Mexico suggests that Villa may be unable to promote a settlement because he has estranged the Church and the *cientificos*. The power of the Church is not one to be disregarded by a serious statesman or even an intelligent bandit, nor can the ruler of Mexico flout mammon, in the person of the *cientificos*, with impunity.

RUSSIA.—The Caucasus Copper Company's operations at Dzansoul, 40 miles from Batoum, have been interrupted by an incursion of Turks on November 17, since which date no information has been received at the London office. Most of the staff, including 50 British and American employees, escaped, by way of Tiflis, into Russia on the day preceding the attack. Mr. A. A. Clement, the accountant, who was wounded, has died since. Mr. Robeson T. White, the manager, was assaulted while going to the mine, with the result that his horse was killed under him and he himself was wounded in the calf of the leg. The injury was not serious. He is now at Petrograd.

The Lena Goldfields has done well during the past season, as the following figures show:

	Cubic yards.	Yield of gold.	Average per yard.
1913	850,500	£1,251,564	29s. 6d.
1914	873,635	1,500,150	34s. 4d.

Gold valued at £108,618 was purchased, presumably from those that had stolen it while at work.

The season at the Orsk Goldfields having come to an end, it is possible to compare results. The total operating profit is about £35,000, as against £36,563 last year, when this purely nominal 'profit' was finally reduced to a real profit of only £679. The misuse of the term 'profit' by this company, and the Troitzk, is persistently pathetic.

Drilling results at the Zeranovsk mine of the Russian Mining Corporation are promising. One bore penetrated four separate bodies of solid sulphide ore, aggregating 58 feet in thickness, together with 27 feet of concentrating ore. The second bore is now in solid sulphide ore. Complete assays are delayed by lack of chemical supplies.

OIL.—The transfer of the Lobitos Oilfields to Standard Oil control is officially contradicted. We note that the Mexican Eagle has paid a second dividend of 4%, making 8% for the year ending June 30, 1914. Considering the disorder prevalent in Mexico, this beginning of dividends is encouraging.

The Commonwealth Oil Corporation, which has had a chequered career ever since its formation in London in 1905, is the subject of a proposal by an Australian oil merchant, Mr. John Fell, for its resuscitation. The properties owned by the company contain oil shale, and are situated in New South Wales. The mining and distillation problems have caused insuperable difficulties to those in control. Two years ago, the effort of the official trustee for the debenture-holders to raise additional capital on prior-lien bonds was unsuccessful. Mr. Fell's proposition is to amalgamate his business with that of the corporation, to erect improved distilling-retorts, and re-organize the method of mining. The present time is, of course, not favourable to the issue of the prior-lien bonds, and leeway is to be given in this matter. But in the meantime Mr. Fell will conserve the assets of the corporation, and for this mercy the debenture-holders are appropriately thankful.

VARIOUS.—The Oceana Development company's concession of 75,000 square miles acquired a year ago in the Belgian Congo, together with the right to select 1,370,000 acres under rights of research, marks an important extension of British mineral exploration. A prospecting party, sent out in February, has been at work, with the result, so far, of selecting 100,000 acres of promising territory. The outbreak of war has stopped this useful work.

In common with other tin-mining companies the Renong has suffered from the fall in the price of tin, the average for the past year being £170 as against £215 in the previous year. Only the No. 1 dredge was at work during the twelve months ending in June, but the No. 2 and 3 dredges have been started since then. Mr. Frank Nicholls, the capable manager, has had to face many difficulties, among which we may mention the nature and depth of the alluvium, and the shortage of water during the dry season, followed later by heavy floods. The overburden of stiff mud renders a plentiful supply of clean water particularly necessary. Among the evidence favourable to the enterprise, we note the uniformity of output made by the No. 1 dredge and the apparent regularity of the tin contents, which have averaged 14·2 oz. tin per cubic yard during four years, as against 14·98 oz. during the year under review.

The latest reports from the Silencio gold mine in Colombia, belonging to the Frontino & Bolivia company, are highly gratifying, as the developments during the last few months have disclosed high-grade ore at all points. Moreover, a rich shoot has been found in a new lode. The arrears of preference dividend have been paid, and the ordinary shareholders may expect a return on the current year's working. A new pump has been installed, so that sinking can shortly be commenced below the 13th level. Ten additional stamps have been erected, and Mr. A. E. Drucker is designing a slime-plant. The company is about to reap the benefit of the re-organization of mining methods, recommended three years ago by Messrs. Pellew-Harvey & Co., and conducted under their guidance.

The Aramayo Francke tin mines in Bolivia were closed on the outbreak of war, because the market in Germany for part of their product was not available, and the presence of German battleships in the South Pacific prevented the safe delivery of concentrate to England. Though mining was suspended, the concentration plants continued in operation on reserves of ore at surface. In December the conditions improved and mining has been re-commenced. This company during its last financial year produced 3442 tons of 60% tin concentrate from 43,366 tons of ore, which represents a yield of 8%, a figure regarded with envy by lode-tin miners in other parts of the world. The company is about to erect a leaching plant for the silver-tin concentrate, which did not find a remunerative market either in England or Germany. Silver-tin ore was the first to be mined in the early days of the Spanish conquest, and the greater part of the ore that could be treated for the extraction of silver without preliminary concentration was removed by the Spaniards.

In Italy the lead mines are being worked uninterruptedly, but zinc production has largely ceased, as it was under contract with the Belgian smelters.

METALS.—The copper and tin markets have strengthened, though occasional setbacks still occur, and prices are higher, at £59 and £152 respectively. Large supplies of zinc are being drawn from the United States, and the price is firm at £28. The price of lead remains without much change at £19, that of standard silver at 22½d. per ounce, and that of quicksilver at £11. 5s. per flask. The Russian demand for antimony has forced the price upward, and the quotation is now £60 per ton.

EDITORIAL

ONE or two American friends have written to us protesting against the strong wording of some of our editorials on the war and the causes of the war. One of them even suggested that we ought to be "judicial" and "scientific" in our treatment of the case. To them we reply that we are not neutral, and we cannot be judicial, in matters that touch our inmost fibre. When a man's house and family are attacked, he does not take a judicial or a scientific view of the desires or ambitions of a burglar; when a man's country is involved in a defensive war, he supports the national cause as best he can.

WITH deep regret we have to record the death of Samuel B. Christy, so long and so honourably identified, as professor of mining and metallurgy, with the University of California. An earnest student, a hard worker, and a painstaking teacher, his passing will be a cause of sorrow not only to the many men that have undergone educational training at his hands but to an even wider circle of those that had learned to know and to respect him. To the President and Faculty of the University we offer our sincere sympathy.

THE Institution of Civil Engineers has issued a report from its special committee on the practical training of engineers. It deals with railway, mechanical, dock, municipal, waterworks, gasworks, and manufacturing engineering, but ignores mining. And yet this institution tries to prevent our Institution from obtaining a charter, on the ground that the Civil Institution includes mining engineering within its scope.

MISTAKES in naming the various mining organizations are common. The correct form and title is the Institution of Mining and Metallurgy, the American Institute of Mining Engineers, the Mining and Metallurgical Society of America, the Canadian Mining Institute, and the Australasian Institute of Mining Engineers.

SEVERAL of the doubles of geographic nomenclature are in evidence now. Galicia in northwestern Spain is a province not to be confused with the Galicia of Halicz and Hungarian conquest. Even Silesia, now the object of warring armies, might easily be confused with Cilicia, in Turkish Armenia. The Carpathian mountains are far from the Carpathian sea, which washes the island of Carpathus, near Rhodes, in the Ægean.

A REFERENCE to "that perverted sentimentalist Chamberlain" in our November issue, in the article on 'Kultur,' has been misunderstood. Lack of familiarity with the literature of Pan-Germanism may excuse an Englishman for supposing that this was a reference to a famous British statesman, when, of course, it referred to Houston Stewart Chamberlain, an English-born writer living in Germany, who wrote 'The Foundations of the XIXth Century,' a book that was written to prove that the Germans—that is, the population of northern Europe—were the elect of mankind. No wonder the Kaiser

thought so highly of the book when he ordered 80,000 copies for general distribution in libraries and reading-rooms. It added fresh fuel to the inflammatory dogma of Pan-Germanism and contributed to the intellectual arrogance that hastened the War.

REFERENCES to the War are now frequent at annual meetings, any timely sentiment from the chair finding ready sympathy among shareholders. One of the most interesting of such references was the explanation given by Mr. F. A. Govett for Mr. H. C. Hoover's absence from the Burma Corporation meeting on account of a second visit to Belgium in the interest of the Relief Commission, the chairmanship of which Mr. Hoover accepted on the personal request of President Wilson. Another, more direct, reference to the War was made at the meeting of the Sulphide Corporation, when the chairman, the Earl of Kintore, mentioned that an 11-inch shell fired from a German battle-cruiser, during the East Coast raid on December 16, exploded in a field at the back of the house occupied by the manager of the Seaton Carew zinc smelter. The "baby-killers of Scarborough," however, did no damage to the plant itself, but the bombardment necessitated the removal and internment of the German and Austrian workmen, who, up to that date, by the sanction of the Government, had been kept employed, under military supervision.

WHETHER it be the feeling of solidarity engendered by the great cause we all have at heart or whether it be the goodwill to men usual at the Christmas season, it is noteworthy that several recent company meetings have been marked by expressions of gratitude and appreciation to the directors and managers. For some of this Mr. A. B. Bosher, of Sheffield, may be credited. Lord Harris made a mistake when he yawned at this gentleman, whose cheery expansiveness of speech might have become an attractive feature at Gold Fields meetings. Certainly at the Van Ryn and Champion Reef meetings he gave felicitous expression to the shareholders' appreciation of good dividends and excellent management. Another gentlemen to give a human touch to proceedings often in danger of arid formality is Mr. Vere Herbert Smith. While paying compliments, well deserved, to the administration of the two mines already mentioned, and of the St. John del Rey, he made reference to the importance of the fact that the majority of the gold mines of the world are operated under the Flag. It is well that our people should know this and at the same time appreciate the bigger fact that the Empire is largely the result of mining enterprise. Indeed the managements of the three companies mentioned are well worthy of commendation, and we take further pleasure in noting that they control two of the deepest gold mines in the world. Certainly we believe such persistence in depth to be exceptional, but that does not restrain our wish that these mines may continue indefinitely prosperous.

IN reading the report of a recent discussion at a meeting of the Institution, we were struck by the literary injustice done to one of the speakers, whose outspoken utterance suffered by transcription from the first to the third person. The evidence of a scientific witness, it seems to us, should be given with the egotism of legal testimony. As soon as it is transcribed into the less personal and less vivid record of a reporter, it loses the force and quality of the *ipsissima verba* uttered by the speaker himself. In the same bulletin we read that Mr. Blank "believed that it [the Empire mine] was near the North Star." As the speaker knew beyond doubt that this was so, he said so plainly, omitting any qualifying term such as "believed." It is, of course,

considered polite not to state facts bluntly in a dinner-party conversation, but when giving testimony before a technical society, it is poor taste to speak in wooly ambiguities. The reporting of statements in the third person is based upon Parliamentary tradition, but it will have been noticed that in recent years any specially important portion of a political speech, in Parliament or outside, is given in the exact words of the speaker, in order to be both more accurate and more impressive. We submit to the council of the Institution that its proceedings as recorded in the bulletins and in the annual volumes would lose nothing, and might gain a good deal, by abandoning the transcription from the first to the third person.

IT IS not our custom to publish any sort of annual review, because this Magazine is a monthly periodical and concerns itself with the progress of events within the smaller subdivisions of time. However, we may join with our readers in dismissing 1914 with a sigh of relief and welcoming 1915 with a cheerful forward glance. In wishing you, Sir, who reads this, A Happy New Year, permit us to draw your attention to the fact that the basic industry of mining proceeds with an activity that this great war has only slightly diminished. The winning of gold, particularly, proceeds with almost its wonted vigour, while sundry other metals are even in increased demand. The mining of the great base—and basic—metals of civilization, namely, copper, lead, zinc, and tin, is suffering from the restrictions of maritime commerce and the crippling of international credit, but it is certain that the restoration of peace will be accompanied by a great demand for these metals, on account of the destruction due to the war and to the re-construction that must follow. At present it is the speculative part of mining that has been destroyed, not the industry itself. That is rooted in the necessities of mankind and will revive to accustomed fruitfulness when the war is concluded. So we look forward to the peace that shall crown the victorious campaign of the Allies.

ARCHANGEL, on the White Sea, has jumped into prominence during the war as a commercial port, affording a trade-route to and from northern Russia, when the Baltic is closed. Our columns will have recorded the fact that several mining engineers have come from Siberia to London through Archangel, thence round Scandinavia to Scotland. Hitherto the White Sea has been closed in winter by ice, but this year the mildness of the season has been assisted by ice-breakers brought from the Baltic and Canada. So we hear now that navigation still remains open. Unfortunately the single-track narrow-gauge railway connecting this port with Vologda, on the main line, is quite inadequate for the increased traffic. We presume that this branch railway will be double-tracked and widened, for it is clear that Archangel is destined to sustained commercial importance. It is a curious fact that no connection exists between the Finnish railways and those of Sweden, a gap of only 20 miles separating Karungi and Torneä. In winter this would furnish a better freight-route from London to Petrograd than any of those already established. Incidentally, we may refer to the further invasion of the Arctic made by the steamship service from Scotland to the Yenesei. Last year three steamers transferred their freight at the mouth of the river, whence it was taken by smaller steamers to Krasnoiarsk. Next summer this service is likely to be increased, so as to afford cheap access to the mines of Central Siberia. At the same time it may facilitate prospecting in the vast tracts bordering the Arctic, the invasion of which, on the American continent, has been a striking feature of modern mining, as is instanced by Dawson and Nome, and exemplified on the European side by the suc-

cessful mining of high-grade coal in Spitzbergen, 600 miles within the Arctic circle.

Pato.

The chairman of the Oroville Dredging company, Mr. F. W. Baker, was able to make a cheerful statement at the annual meeting. The debt of £65,000 incurred in connection with the equipment of the Pato property will have been liquidated at the end of the present month, and it will have been done from the yield of gold obtained on that Colombian property. Mr. Baker took great pains to explain the complicated financial relations between Oroville Dredging and its two subsidiaries, the Pato and Nechi. The explanation must have been welcome to the shareholders. Coming to the mining operations, we note that the Oroville dredges won 8·68 cents per cubic yard at a cost of 4·04 cents, the latter being 1·58 c. lower than last year. For this Mr. C. W. Gardner, the manager, deserves credit, as suggested by the chairman. The Pato dredge extracted $848,114 from 1,400,240 cubic yards, or 60·5 c. per yard, from the 310 acres that were estimated, on the basis of drilling, to yield an average of 31 c. per yard. Thus the yield is nearly twice that estimated, and stated in the original report. This discrepancy is explained, in a measure, by Mr. W. A. Prichard, who made a thorough investigation. He concludes that the drill-holes were too far apart, namely, only one bore to each 10 acres; the richest ground, forming a strip only 500 feet wide, being penetrated by two or three holes only. Nevertheless the discrepancy between the estimate and the realization is yet to be explained satisfactorily. Evidently the dredge was steered to the richest part of the property, yet Mr. Prichard says that the yardage dredged in this selected ground is "such a small part of the total prospected area that the general average of the remainder will not be greatly reduced, as might be feared." The statement hinges on the adverb "greatly." In his recent report Mr. Prichard gives 31·6 cents as recoverable on 528 acres, for an average depth of 26 feet, representing 22,400,000 cubic yards, yielding $7,000,000. We omit fractions and odd numbers that have no significance. Thus his average yield per cubic yard is practically the same as that in Mr. C. H. Munro's report, but 218 more acres are now included in the dredgable area. If these two engineers, at intervals, make an estimate of 31 cents, then, obviously, the dredge cannot continue to yield 60 cents per yard unless either their estimates are wrong or the operations are in ground twice as rich as the average. The cost is given as 17·71 cents per yard during the 11 months preceding September last, as against the 10 cents mentioned earlier as the probable cost. The higher figure is due largely to unexpected checks and misfortunes, but such things constitute a part of the risk inherent in mining and allowance should be made for them by men of experience. Lack of space prevents us from discussing other technical features, but we may be able to do so in our next issue. Meanwhile we join in congratulating the company on its excellent present position and future prospects.

The Metal Trade.

The press accounts of the raids made by the authorities on the offices of sundry mining companies and metal brokers at Melbourne on November 9 illustrates another phase of the impact of war upon industry. The companies thus subjected to sudden inspection were the Broken Hill Proprietary, Broken Hill South, Mount Lyell, Mount Morgan, together with the Australian Metal Company, Max Gorler, Ltd., and W. S. Robinson of Lionel Robinson, Clark & Co. Naturally, this action provoked surprise and even protest, for most of those named may be assumed to be quite innocent. Only one official prosecution has resulted, namely, against F. H. Snow & Co.,

agents for Aron Hirsch & Sohn. The statement made by Mr. Max Gorler shows a proper spirit, and is worthy of record. "I am, of course, a German; I was born and brought up in Germany, and cannot help sympathizing in some way with my fatherland, especially when all the world is against it. I believe, however, that any German who has been 14 years in a country like Australia, as I have been, ought to behave himself." That statement does honour to the man who made it. We have no quarrel with him. Indeed, the trade in metals with enemy-aliens in most cases is, we may safely assume, non-national and merely an expression of the desire to do business, like the American insistence upon non-interference with the trans-Atlantic trade between the United States and neutral countries. They want to sell their products to whomsoever will buy them and care but little whether those products go to one or other among the various belligerents. We, to whom this war is of an importance transcending all ordinary business, do not regard their action in the same light and try to hinder them in so far as their shipments may aid the enemy. It remains for all concerned to keep their tempers and remember that war is an abnormality that transgresses the customary amenities of international trade. Having said this much, we shall express entire approval of the steps taken by the Australian authorities in defence of the Empire. Mr. W. M. Hughes, the Federal Attorney-General, has stated that the information obtained as a result of the raid has sufficed to justiry the action taken. It has had the effect of drawing attention to a state of affairs that is anomalous, at least, namely, the German control of the metal trade of Australia. The High Commissioner, Sir George Reid, has submitted belated information to the Imperial Government, showing that the export of metals from Australia to Germany has been growing apace, a fact that is well known to most of our readers, and has been made clear recently in our articles on the lead, zinc, and copper industries. Just now there is a natural impatience to break free from the obligations of contracts made before the war, particularly in regard to zinc concentrate from Broken Hill, but if it be illegal to cancel those contracts by reason of war, then it only remains to observe the obligation and resolve to take honourable steps whereby in the near future the British metal industry shall not remain in the control of aliens. The first necessary step is for the Government to exchange its *laissez faire* policy for sympathetic interest in these economic matters. Whether it be contrary to public interest and the national safety to permit these contracts to kill further enterprise, it remains for the Government to decide. If it be so, then Parliamentary action involving legislation may be required to enable the Government to assume any liabilities arising from the cancellation of contracts with enemy-aliens, to be followed by a settlement at the close of the war. Meanwhile this control of the metal markets extends beyond Australia. It is dominant in London, as has been made public by the criticisms of sundry newspapers, two of which started a crusade, which was blocked forthwith by writs served by the parties attacked. We need only look from Melbourne to London, and from London to New York, and finally from New York to Frankfurt, to realize that the base-metal market is under the enterprising thumb of persons whom we now number among our enemies. The broad fact is covered, to a large extent, by the cloak of naturalization and even by operations under the names of old-established British firms. But this does not justify either the suggestion of dishonouring contracts or for a vain foaming at the mouth against German enterprise. It will be more seemly, and more practical, to recognize the fact that many of our old firms have lost their initiative, by passing into the hands of less energetic successors, and that the German metal-

merchant has exhibited great astuteness. Let us pay him the compliment of playing him at his own game, awaken to our lost opportunities, and resolve to regain a position we have lost. And let us do it, like our soldiers in the trenches, with good humour. Obviously, it is foolish to allow Australian concentrate and blister copper to go to Germany for final treatment, to give the contract for the sale of refined copper to German firms and to buy our lead, zinc, and copper from the gentlemen at Frankfurt or Halberstadt, with agencies at Melbourne and London. It is also absurd for our Admiralty to buy its metal supplies from any but British firms, or for our Government to employ as official metal-buyers the English representatives of German firms. The remedy is to smelt and refine the products of mine and mill within our own territories. Another plan, in keeping with the tragic circumstances of the war, will be to furnish capital to the Belgians for the erection of smelters in Belgium to treat a large part of the Australian metal products, thereby aiding the rehabilitation of industry in Belgium and at the same time controlling the disposal of the output to mutual advantage. Beyond all this, an effort should be made to divorce the brokerage in metals from the beneficiation of the mineral products, so that the metal market may be less of a delusion and a snare. Circumstances call for patriotic, intelligent, and effective action to remedy an imperial scandal. We have the mines, we have the men, we have the money too; it only requires sane co-operation.

Naturalization Again.

Among the regulations marking the re-opening of the Stock Exchange is one that requires members of alien origin to exhibit their letters of naturalization. At the same time those who were formerly citizens of countries with which Great Britain is at war, are ordered "to satisfy the committee that they have been denationalized in their country of origin." As we mentioned in our October issue, the citizens of Germany, more particularly, have been able to retain their nationality in Germany while obtaining the rights of a British citizen by naturalization. We have seen it stated that an act was authorized by the Reichstag in July, 1913, whereby a German subject loses his nationality *de facto* the moment he takes the oath of allegiance to another country. This act is said to have come into force on January 1, 1914, according to the *Kölnische Zeitung*, for example. But we are not aware of any official confirmation. The action of the Stock Exchange Committee, in consultation with the Treasury, appears to contradict any such assertions concerning recent German legislation. Since the war began several naturalized members have returned to the country of their origin, to join the army of the Enemy. Moreover, it is now known that the heavy sales last July, accompanied by enormous withdrawals of gold, precipitating a panic, were made by sundry Stock Exchange firms in close touch with Berlin. Their anticipation of war, based on advices from Germany, was used to diminish our resources to the extent of, at least, forty millions sterling. In other words, having taken the oath of allegiance to the King, they worked for the Kaiser. We regret only that the new rule, like others based on distinctions of nativity, will cause many unmerited hardships. International finance and business generally are based on the continuance of non-national amenities; it is only in time of war that the place of a man's origin becomes of any importance to broker or client. In short, war is abnormal. While therefore we regret the brutalities incidental to the times, we cannot drop the discussion of this unpleasant subject without recognition of the fact that by her system of civilian espionage in time of peace, by her abuse of such international hospitality as is involved in the naturalization of her subjects, and by financial aggression

before the actual declaration of war, Germany has transgressed the code of civilization. All this must be particularly distasteful to Germans now naturalized among us. It remains for them to state openly that they repudiate such methods and intend to support the country of their adoption loyally. Therefore we suggest that all naturalized Germans and Austrians should join in presenting a declaration of their allegiance to the King and of their loyalty to the Kingdom. That, more than any purely legal ceremony, will range them with us definitely and enable us to live and work with them in harmony.

Burma Corporation.

The report on the Bawdwin mine, made by the Technical Committee and appearing in the annual report of the Burma Corporation, is of unusual interest. We have referred to this mineral discovery in earlier issues, over a year ago, as being one of the most important made during the last decade. In Mr. H. C. Hoover's speech, read, in his absence, at the recent meeting, he speaks of it as one of the 10 notable mineral discoveries of the first rank made during the last 14 years. That leaves us to guess at the other nine, uncovered since 1900. We hazard the Mohawk orebody of the Goldfield Consolidated, the Hollinger, Perseverance-Gastineau, Miami, Braden, Chuquicamata, Kyshtim, and Ridder. Turning to our more immediate subject, we find that the technical report justifies anticipations. The ore-channel of the Bawdwin mine has been traced for 8000 feet and for a width ranging from 350 to 500 feet. In this big lode several orebodies have been found, the largest being the Dead Chinaman, which is 1200 feet long by 50 feet wide, and has been traced now by development to a depth of 200 feet below the main adit or 700 feet altogether from the mean surface. On the 102-ft. level the ore averages 12 oz. silver, 15% lead, and 20% zinc, while on the 171-ft. level the average is 19 oz. silver, 24% lead, and 20% zinc. The grade on the upper level corresponds with the average ore now being worked at Broken Hill, but the lower level exhibits an assay-value higher than obtains in any great silver-lead-zinc mine in the world. The engineers constituting the Technical Committee estimate 440,000 tons as proved between the two levels mentioned, and they estimate further that 870,000 tons is reasonably assured to 200 feet below the lower of these two levels. This additional tonnage is based on data obtained from the shaft and drill-holes. The latter have sampled the orebody down to 287 feet below the 171-ft. level, while the shaft has penetrated to a depth of 200 feet. The cross-cuts from the shaft have exposed ore below the old Chinese workings, which extend, so far as known, to a depth of 40 feet below the 171-ft. level or about 600 feet from the surface, and in this virgin ground the ore is considerably richer in silver and lead.

The ore-channel traverses beds of felspathic grit, lying against a foot-wall of rhyolite, which, presumably, is connected with the thermal activity causing the deposition of ore. A later series of sedimentaries caps the ore-bearing rocks. The deepest workings are well below the zone of oxidation. Hence the engineers conclude that the evidence is favourable to the persistence of the orebodies to a greater depth. Certainly, the prospects are good. In regard to metallurgical treatment, it will be remembered that the enterprise was started to beneficiate the old slag-dumps left by the Chinese. For this purpose, a lead smelter was erected first at Mandalay and then removed to Nam Tu, 13 miles from the mines, which at that time remained unexplored under a cover of thick jungle. This smelting of old slag continues, thanks to the demand for lead, in the East more particularly. Sulphide ore is now being treated, in addition to the slag, and roasting-furnaces having a capacity of 80 tons per diem are being erected. Meanwhile

experiments, using water and oil concentration, are being made with a view to treating the main output of the mine, namely, an extremely intimate mixture of lead and zinc sulphides. Before the war some of this material found a market at Antwerp, so that it cannot have been quite so refractory as it looked. We understand that the experiments are promising.

The Coppermine River.

Two years ago we expressed lack of sympathy with the hysteria of Arctic exploration and even ventured to deprecate the histrionic gymnastics of Polar expeditions. At the same time we suggested that the energies of the explorer could be better employed in penetrating unknown parts of the earth possibly suitable for human industry than in providing material for the cinema show and the sensational press by making useless dashes over the Arctic and Antarctic icefields. We instanced the Great Northwest of Canada as a region offering scope for such intelligent exploration as is the pioneer of industry. At the time we made our protest, this view of the subject was being illustrated, without our knowledge, in a most effective manner. The result comes now in a book called 'Lands Forlorn' in which Mr. George M. Douglas describes the journey made by himself and two others to the mysterious Coppermine river on the Arctic rim of the North American continent. This lone land, between Great Bear lake and Bathurst inlet, roughly midway between Hudson's bay and the Yukon, was first made known by Samuel Hearne, who, in 1770, accompanied a party of Indians to the place whence they had obtained lumps of native copper. He discovered Great Slave lake and was the first white man to reach Canada's Arctic shore. On this journey he saw only one piece of native copper and, in his ignorance, was greatly disappointed. Captain Franklin and Dr. J. Richardson, on their return from Captain (afterward Sir John) Franklin's journey to the Arctic in 1819-1822, saw the copper deposits but made no serious inspection of them. In 1902 David Hanbury found copper float on the Coppermine river when returning from the Arctic to Great Bear lake. He and an earlier explorer, Thomas Simpson, had more to say concerning the copper of Bathurst inlet, although it was the bringing of native copper from the Coppermine river, by Indians to the Hudson's bay post, that started the tradition. Many of our readers will remember an interesting résumé of references to the subject submitted by Mr. J. B. Tyrrell in a paper read before the Canadian Mining Institute in 1912.

All this is now a mere background to the actual examination made by Dr. August Sandberg, a Swedish geologist, one of the party of three whose doings are recorded in Mr. Douglas's book. We shall not dwell on the charm of the book itself, which we could hardly lay aside once it was in our hands, but we take the opportunity of instancing this expedition as an example of intelligent and useful exploratory work. The expedition returned with maps, photographs, and samples. The geological data indicate a striking resemblance to the Lake Superior copper region. A series of basaltic flows is found interstratified with beds of conglomerate, dipping at a gentle angle and forming ridges and terraces. Native copper is found in the upper amygdaloidal portion of the basalt layers, and in the beds of conglomerate, in association with calcite and epidote. A breccia containing chalcocite with quartz and calcite is also noted. The expedition confirms Sir John Richardson's identification of these copper-bearing rocks with the melaphyre and conglomerate of the Keweenaw series on Lake Superior. The rocks congenial to native copper extend northeast and southwest for about 300 miles and may extend over an area even larger than

the corresponding series on Lake Superior. Two samples, at least, contained enough copper to suggest the makings of a mine. In short, as Mr. James Douglas says in the introduction to his kinsman's book, "the region may become one of the great copper producers of the world." It is true the region is as yet inaccessible, but the easternmost end of it is only 500 miles from navigable water in Hudson's bay over a possible railway route. The summer is short and the climate severe, but Alaska and the Yukon, not to mention Lake Superior itself, afford a measure of man's productive activity in regions once deemed equally inhospitable. Lignite is plentiful and better coal is likely to be found nearer than is at present known, judging from analogy with other parts of the Northwest. It may seem a far cry now from London to the Coppermine, but many of us remember when Frederick Schwatka's exploration of the Yukon first made known that great river to those that dwell beside the trodden ways of civilization. Not enough technical information is available yet to appraise the industrial possibilities of these copper deposits, but the expedition headed by Mr. George Douglas furnishes an example of exploratory work likely to prove fruitful; it was no grand-stand display to impress the mob, but an unpretentious and useful addition to our knowledge of a distant corner of the Canadian dominion.

Ore.

The continued interest shown in the attempt to formulate a definition of ore consonant with intelligent usage will excuse another reference to the subject. We have been approached by several engineers willing to assist in our effort to arrive at a just definition, and we learn from them that the chief obstacle to the acceptance of the definition previously offered is that it does not include mineral about to be exploited or low-grade material capable of yielding a profit under conditions shortly to be attained. In other words, reasonable expectancy is a factor that should not be ignored. That aspect of the problem has been mentioned, among others, by Messrs. Trewartha-James and D'Arcy Weatherbe. Therefore we proffer a modified definition: "Ore is rock from which the miner may reasonably expect to extract metal to his economic advantage." Is that nearer the mark? The word 'miner' is here used in its comprehensive sense, viewing the geologist, metallurgist, and chemist as collaborateurs of the prime agent. 'Miner' means the intelligent and experienced man or men that direct the operations of a mine: primarily, the mining engineer, but secondarily the mine-owner, syndicate, or company operating a mine. The expectation must be 'reasonable'; not the unreasonable hope of a sanguine promoter or the wild dreams of a reckless operator, but the logical estimate of persons properly versed in the technology and business of mining. The definition covers the discovery of an orebody of such general character and richness, and under such economic conditions, as to justify the supposition that it can be exploited advantageously as soon as the necessary facilities of transport and of treatment are provided; such facilities being assured, of course. It covers old dumps suitable for re-treatment when improved methods or better markets have brought them within the scope of profitable exploitation. 'Extract' includes the whole sequence of operations, from the mine to the mill or smelter, and even to the market, for that is the final stage of realization, included in the idea of 'economic advantage.' This last qualification is essential in order to tie the definition to realities, as distinguished from the academics of the geologist, the vagaries of the visionary promoter, or the mere verbiage of the irresponsible scribbler. We add 'his,' because the extraction of metal from rock is to the general economic advantage of the community or of the world at large even when it is effected at

a pecuniary loss to the miner. But such extraction cannot continue long except as an unreasonable performance outside the scope of any intelligent definition. If the State operates a mine at a pecuniary loss in order to give employment to its people, then the State becomes the 'miner' and is performing the work to its economic advantage. So the definition covers this apparent exception. Of course, the primary aim of mining is to win the metal from the ground, but it is done not to benefit the world, but to make money. The miner is not an altruist; he is guided by intelligent self-interest. If the State should operate a mine at an apparent loss because it requires metal at any price, as the German government might exploit the Mansfeld copper mines at the present time even if the extraction of the copper cost two or three times its peace-time price, it would only mean that the metal was now worth to Germany as much as two or three times its normal value. Then the copper would be extracted to the economic advantage of the Government, which would be the 'miner.' Similarly, the Broken Hill companies might operate their mines on half-time even if they saw no immediate market for their lead or zinc, being prompted to continue exploitation in order not to lose their staff or disorganize their administration. It might be to their economic advantage to do so, despite a temporary financial loss. Finally, we venture to suggest again that non-profitable material, resembling 'ore,' can be called 'mineral.' Banket assaying 2 dwt. per ton on the Rand becomes gold-bearing mineral but not 'ore,' because no reasonable expectation exists that the gold can be extracted to the economic advantage of the miner, that is, the mine-owners, the shareholders, or the company, within any reasonable period of time. In mining we take short views of life; the personnel of the proprietary changes from year to year; the management is not fixed indefinitely; those in control are not working for posterity. A time limit is assumed. An imaginative metallurgist might prophesy the day when a selective solution is discovered capable of attacking the secondary silica cementing the pebbles of the banket without attacking the pebbles themselves, thereby revolutionizing the whole scheme of treatment and reducing the cost of it to such a degree as to bring millions of tons of gold-bearing 'mineral' within the economic limits predicated by the term 'ore.' But that is not the reasonable expectation of a sagacious man; so we discard it. Then we have 'rock,' 'waste,' 'mineral,' and 'ore'; within the limitations of these terms the miner and the mining engineer should find ample facility for indicating the character of the various materials coming within his practical cognizance. Therefore we submit the definition as revised: "Ore is rock from which the miner may reasonably expect to extract metal to his economic advantage."

The Great Crime.

With the publication of the French diplomatic correspondence preceding the war and the disclosures made by the Italian ex-Premier, Signor Giovanni Giolitti, we have all the materials necessary to determine the responsibility for the Great Catastrophe. The prompt publication of the British White Paper, on the day after war was declared, was followed at intervals by similar official records issued by the Russian, German, and Belgian governments. Of these, the least complete was that emanating from Berlin, for it lacked the correspondence with Vienna. Of the bigger belligerents Austria alone has given forth no official statement, leaving it to her ally to make the best of their joint case. Never in history has the diplomacy precedent to war been so mercilessly exposed, and never before has the world at large realized the callous insincerities that prevent the preservation of peace among civilized peoples. Three

months ago we accepted the assassination at Serajevo as the beginning of the end; we know now that it was only the end of the beginning. Since then we have been able to go behind the tragic event of June 28, 1914, to see that it was merely an excuse for the deliberate policy of an autocratic military system.

On December 5, 1914, Signor Giolitti, speaking before the Italian Chamber of Deputies, stated that on August 9, 1913, the day before the Treaty of Bukarest terminated the second Balkan war, Austria communicated her intention to proceed against Serbia and asked Italy to regard such steps as she was about to take, in accord with Germany, as a defensive measure coming within the scope of the treaty binding the members of the Triple Alliance. Italy declined to regard such action as defensive, and refused to participate. At that time Austria proposed to launch an ultimatum against Serbia in terms similar to those of the note actually delivered on July 23, 1914. Thus the murder of the Austrian Archduke was not a cause, but merely a pretext, for a step contemplated a year earlier. Italy's opinion was expressed in 1914, as in 1913, by refusing to support her two partners in their aggression, an aggression that promised to involve Russia, and therefore France, in war. This was acknowledged in the German official explanation, wherein it is stated: "We were fully aware in this connection that warlike moves on the part of Austria-Hungary against Serbia would bring Russia into the question, and might draw us into a war in accordance with our duty as an ally." That acknowledgment is damnatory.

By way of further confirmation we have the disclosures in the French Yellow Book. There is recorded the secret official report of March 19, 1913, on the increase of the German army in order "to strengthen and extend Deutschthum throughout the entire world;" the preparations for this supreme effort to be preceded by teaching the German people to accept the idea of an offensive war and by weakening their intended enemies through intrigues in North Africa, Russia, and Egypt. Finally, it is stated, the small neutral countries "must be forced to follow us [Germany] or must be cowed." Belgium, in particular, is marked down for disciplinary measures; if she organized for defence against Germany, then the latter "could not in any way offer Belgium any guarantee of the security of her neutrality." In November of the same year, the Kaiser, the King of the Belgians, and General von Moltke held a conversation in the course of which the last stated that "this time we must finish France." Earlier in that year Von Moltke had said: "Commonplaces as to the responsibility of the aggressor must be disregarded." Thus did coming events cast their shadows before. When the crime of Serajevo gave the excuse, the long prepared plan is put into execution. Germany gives Austria a blank cheque and an uncompromising ultimatum is sent to Belgrade from Vienna. The government at Berlin pretends not to know the terms of this note, to the support of which it is fully committed. Yet we are informed that the Bavarian Prime Minister had cognizance of the Austrian note and throughout the negotiations the German Secretary of State exhibits curious unconcern as to the contents of the Austrian note or of that in which Serbia replied. The impression we obtain from the diplomatic exchanges is that Herr von Jagow and his chief were following a plan already cut and dried. Hence the hurry to the climax. Hence also the tragedy to which events converged with all the inevitableness of a Greek play. The assassination of Belgium was to ring up the curtain of a world war. For that the Prussian military machine was prepared, but, it is now evident, not for the entry of Great Britain upon the stage.

Yet before we come to the climax of the

European tragedy, let us turn to the earlier scenes that prepared the way for the last act. The great crime was hatched half a century ago. It was Treitschke and the Prussian school of historians that sowed the dragon's teeth, receiving their inspiration from the successes of the unscrupulous Frederick. Consider, for example, the manner in which he took Silesia from Maria Theresa. Then came the easy victory over Austria in 1866 and the crushing conquest of France in 1870, with the sequel of pride and prosperity that turned the heads of the Germans and intoxicated their military leaders. The Treitschke tradition was expounded by a whole school of writers from Clausewitz to Bernhardi, while the head of the state, the Kaiser, gave such touches of vivid colour as were needed to complete the dream of world dominion. The German professors, doing obeisance to the War Lord, proceeded from the vision of the super-man to the delirium of an imaginary super-state dispensing kultur over creation. Thus the Teutonic myth grew to the phantasmagoria of Pan-Germanism. From the perverted reading of his country's history, the German passed to an obsession that "polluted the conscience of a mighty people," turning their ideals of intellectual advancement to a piratic plan for winning the hegemony of Europe. War as a biological necessity, conquest as a means of expanding empire, truculence as a method of extending business, these and all the other corollaries of relentless militarism possessed the Prussian state and dominated the German confederation. By organizing a big army ready to mobilize at a moment's notice and by creating a navy prepared to facilitate foreign invasion, the Kaiser was enabled to shake his mailed fist under the nose of anybody that stood in his way. Germany successfully intimidated the Great Powers in turn, expecting to assert her supremacy either by threat or, if necessary, by the sudden application of force. The diplomatic correspondence shows now that Russia was either to be deterred from coming to the support of Serbia or to be compelled to fight at a disadvantage. If she proved timorous, she would lose the leadership of the Slav peoples; if she resisted the smashing of Serbia, she would herself be punished, being thought to be ill prepared for war, by reason of internal political troubles, incomplete recovery from the Japanese campaign, and the inability to mobilize quickly. France, of course, would come to her assistance, but France was deemed decadent and could be crushed by prompt invasion through her unfortified Belgian frontier, leaving Germany free to dispose of Russia. England was peace-loving, supine, harassed by political dissension, and embarrassed by disloyal colonies. Belgium would lie down and allow the Prussian Juggernaut to walk over her. This was what the Prussian war-makers told the German people, not in so many words but by implication, through the lectures of professors, the writings of military propagandists, and the flamboyant flummery of irresponsible journalists. The German, flattered by perverted historians, intoxicated by his real industrial success, hallucinated by an emperor that claimed the Deity as his side partner, accepted the promptings of his military leaders and welcomed the great adventure that was to give him world dominion. The armament manufacturers, the naval and military cliques, above all, the paranoiac Kaiser, united in leading him down a steep place into the abyss of a great catastrophe. And not the German only, but other nationals also. The crime is not against the fatherland of Goethe and Schiller, of Beethoven and Lessing, only; it involves the whole of Europe; it has driven civilization to the shambles. It began with the assassination of Belgium, and it will not end until millions of innocent men, and women, and children, have been sacrificed on the bloody altars of war.

PERSONAL.

JOHN F. ALLAN has returned from Mexico.

B. T. ALTSON is serving with the 12th infantry battalion of the South African Defence Force, in German South-West Africa.

ROBERT ALLEN is at the Cam & Motor mine, in Rhodesia.

ROBERT ANNAN is in the Officers Training Corps.

A. CHESTER BEATTY sails for New York, upon a short visit, on January 15.

W. DE L. BENEDICT spent Christmas at San Francisco and expects to remain in California for two months.

C. P. BERESFORD, joint manager of the Prestea mine, has returned from West Africa.

R. S. BOTSFORD is at Petrograd.

F. O'D. BOURKE, manager of the Naraguta, is on his way back to Nigeria.

F. K. BORROW has obtained a commission in the Royal Garrison Artillery.

F. W. BRADLEY was at Washington early in January.

C. T. BRODRICK is working in Belgium for the Relief Commission.

A. O. CAUTLEY is home from Siam.

W. MORLEY COBELDICK is here from Wallaroo, South Australia.

ARTHUR P. COLEMAN has been elected President of the Geological Society of America.

A. E. DRUCKER sailed by the *Trent* on January 13 to erect machinery designed by himself for the Frontino & Bolivia mines, in Colombia.

R. FARINA has returned from the Caucasus and is now in Cornwall.

E. H. FARMER has been appointed chief electrician at the Mount Morgan mine.

NORMAN FORD has returned from Queensland, having served with the Australian contingent in New Guinea.

F. LYNWOOD GARRISON has returned to Philadelphia from Santo Domingo.

H. W. HARDINGE is attending the American Mining Congress.

G. A. HARRISON has arrived from the Altai district, where he has been in charge of the Ridder mine of the Russo-Asiatic Corporation.

KARL HOFFMANN has returned from Cobalt to New York.

W. L. HONNOLD is expected shortly from Johannesburg.

J. POWER HUTCHINS is at the Vagliano colliery, in southern Russia.

CHARLES JANIN has been appointed consulting mining engineer to the U.S. Bureau of Mines.

A. F. KUEHN was married at New York early in December.

OWEN LETCHER is with the Union forces fighting in South-West Africa.

T. M. LOWRY is at the front, holding the rank of captain in the 2nd Duke of Cornwall's Light Infantry.

PERCY K. LUCKE is returning to Mexico on January 16.

G. W. W. MACKINNON is interned as a prisoner of war in Austria.

H. E. NICHOLLS sailed for Northern Nigeria on December 30.

FRANK W. OLDFIELD is metallurgist for the Cinco Minas in Jalisco, Mexico.

F. WARD PAINE, of Boston, was in London.

MAURICE PERCEVAL was killed in military operations in the Cameroons.

A. C. PERKINS is now manager for the Malayan Tin Dredging company.

A. R. PHILLIPS has returned from Burma to Falmouth.

W. A. PRICHARD is here from Colombia, to meet the Pato directorate.

A. L. QUENEAU is now serving as interpreter with the 2nd Wessex Field Company, Royal Engineers.

FRED B. REECE has joined Borden's (Automobile) Quick Firing Battery, of the Canadian contingent.

J. REED sailed for Colombia on January 13 on his way to the Frontino & Bolivia mines.

H. N. REES has returned from Sulitelma, Norway, to Cornwall.

H. P. ROBERTSON has gone to the front as an officer in the Army Service Corps.

C. A. H. DE SAULLES has returned to America.

E. GIBBON SPILSBURY is in Arizona.

HENRY F. STRANGWAYS has returned from Peru.

G. A. SYME has arrived from El Oro, Mexico, to join the Army.

H. W. TURNER sailed for New York on December 12.

SCOTT TURNER sails for New York on January 16 by the *Lusitania*.

E. J. VALLENTINE has joined the firm of Osborne & Chappel at Ipoh, Malay States.

ROBESON T. WHITE, manager for the Caucasus Copper Company, is at Petrograd.

C. WILL WRIGHT has returned to Sardinia from Michigan.

THE ROLL OF HONOUR.

Supplementing Lists in our issues of October, November, and December.

AINSLIE, E. L. M.
Middlesex Regiment.

AIRTH, R. A.
8th Bedfordshire.

ALTSON, B. T.
South African Defence Force.

ANNAN, ROBERT
Officers Training Corps.

ASPLAND, V. L.
R.E. (T.) Wessex Divisional Engineers.

BARCLAY, ALLEN
74th Field Company, Royal Engineers.

BARGATE, GEORGE, JR.
2nd Field Company, Canadian Engineers.

BOWER, J. G.
Transvaal Scottish.

BRADDON, W. CLODE
Royal 1st Devon Yeomanry.

BURLEY, WILLIAM J.
Gold Coast Rifle Volunteers.

CALVERT, C. F. H.
South Staffordshire Regiment.

CALVERT, C. F. H.
3rd South Stafford.

CHAPPLE, H. M.
Royal Naval Air Service.

CASEY, R. G., JR.
Australian Contingent.

DAVIES, W. E.
Royal Welsh Fusiliers.

EWEN, DONALD
London Scottish.

FENNELL, J. H.
Royal Field Artillery.

FRANCIS, M. A.
10th Welsh Regiment.

FRASER, A. J.
1st Lovat Scouts.

GREENWAY, HAROLD
Field Engineers, First Australian Division.

HAND, W. C.
Royal Garrison Artillery.

HIBBERT, ARTHUR
Royal Garrison Artillery.

HILL, H. W.
Sportsman's Battalion.

HOPKINSON, W.
King's Royal Rifles.
(Killed at battle of Ypres on October 31.)

JONES, E. O.
East Yorkshire Regiment.

JOSEPH, E. H. AUSTIN
Rand Rifles, S.A. Forces.

JOWETT, W. H.
Australian Contingent.

KELLETT, A. G. REID
2nd King Edward's Horse.

LAWFORD, E. S.
London Electrical Engineers.

LLEWELLYN, BRIAN
Royal Engineers.

LUTTMAN-JOHNSON, H. M.
Royal West Kent Regiment.

MCKINLEY, J. G.
Royal Flying Corps.

MCMULLAN, G. C.
Royal Field Artillery.

MCTURK, A. G.
2nd Lovat Scouts.

MONCRIEFF, R. M.
6th Black Watch.

NOTCUTT, L. A.
Royal Garrison Artillery.

OKE, A. LIVINGSTONE
Royal Garrison Artillery.

PATERSON, G. S.
Royal Garrison Artillery.

PEARSON, R. G.
Standerton Commando, South Africa.

PEARSON, S. G.
Canadian Royal Army Medical Corps.

POLLARD, E. B.
King's Own Scottish Borderers.

RADCLIFFE, A. F.
R.E. (T.) Hampshire Fortress Engineers.

RANCE, W., JR.
Royal Fusiliers.

REECE, FRED. B.
Borden's Automobile Q.F. Battery.

RICHARDSON, KENNETH
Motor Despatch Riders Corps (South African Forces.)

ROBERTS, HAROLD
Army Service Corps.

ROBERTSON, H. PATRICK
Army Service Corps.

ROBINSON, F. C.
York & Lancaster Regiment.

ROOSE, H. F. G.
R.E. (T.) London Electrical Engineers.

ROUGHT, P.
28th County of London Regiment.

SMITH, H. V.
2nd King Edward's Horse.

SMITH, G. HILDICK
South African Force.

SYME, G. A.
Royal Field Artillery.

WASSE, F. MCLEOD
Royal Garrison Artillery.

WONTNER BROWN, G.
Army Service Corps.

SPECIAL CORRESPONDENCE

MEXICO.

December 1, 1914.

The Zapatistas, or followers of Zapata, entered the city a week ago tomorrow. Last Tuesday, a week ago, when I went home to lunch I heard firing going on very close to our house. I went to see what was the matter and saw in the open fields behind the bull-ring a full-dress parade of battle in progress between some hundreds of the Carrancistas and the Zapatistas, who were at that time in Tacubaya, and had sent their advance guard to the city. Machine-guns were blazing away from the top of the Chapultepec castle, and a devil of a noise was being made. I went forward and got through the Carrancista lines to see how they shot. You never saw such an absurdity. They were simply firing to make a noise, I think. The Zaps were not visible, but these lunatics were riding round and round and firing from their horses at anything or nothing. I got on top of the roof of that big block of buildings that Gore was erecting near Chapultepec, and watched the performance until it stopped, at about 4 o'clock in the afternoon. By that time the Carrancistas had all retreated, and the Zaps were in possession of the outskirts of the city. That night the last of the Carrancistas cleared out, and during the night there was no source of order or authority in the city excepting what was furnished by volunteers. As soon as it was discovered that the Carrancistas had fled, leaving the city unprotected, and that the Zaps were not coming in until the morning, many ex-federal officers, who were in hiding, came out and had a meeting, and went to the foreign legations and asked for arms, to arm volunteers, who would act as police. Arms were given to them, and they patrolled all night. Next day the Zaps entered, quite quietly, without any fuss. I went out to the Country Club at 9 o'clock in the morning, and passed hundreds of them on the road. They are of the peon class, dressed in cotton, mainly rags, and just peon of peones. But the remarkable thing is that good order has been kept. There has been no looting, as was done by the Carrancistas, no stealing of private property on the excuse that the people robbed were enemies of the revolution; in fact, they have done nothing but make people astonished by their good behaviour and good sense. It is another of the unexpected things that this country produces. Here we have been hearing for 4 years of what the Zaps would do once they got into the city, and now they are in they are the most decent lot that have been here since the time of Diaz. One wonders if it can last. It seems too good to be true, only that Villa has now arrived, and is in Tacuba, but will not enter the city until the Provisional President Gutierrez comes to join the triumphal procession, which is due in a day or two. It is said that Villa will at once open up the railways to the north, and that communications will be established as rapidly as possible. Pachuca has already been occupied by the Villistas, the glorious Carrancistas having run away as soon as they were threatened. The Mexican railway has been greatly damaged by the retreating Carrancistas, and Morcom says that the damage they have done may stop traffic for many months. We hear that Wilson, that doctrinaire President, has landed men again to protect merchandise which was in Vera Cruz, and of which Carranza meant to take possession. We hear that his action is due to a peremptory demand from England and France, to put the Monroe doctrine into force, or else pay the piper for the losses that will result. It may not be true [It is not true.—EDITOR.] that more men have been landed, but it is quite on the cards, and I hope that it may be true, just to expose Wilson to ridicule, and to put a spoke in the wheel of that fool Carranza. [These are the expressions of a man irritated beyond bounds by persistent anarchy.—EDITOR.]

We have had no communication, of course, with the outside world for many days, and know nothing of what is going on. Sometimes the cable is open and sometimes not. All we have had from the outside is some

European war news. Carranza has established a rigid censorship over all cables in Vera Cruz, and will not allow any information about himself or his doings to be sent over the line, so that no one knows really what is going on. Rumour is always busiest in such times, and I can assure you that she was never more busy than now. However, we are still safe, and now that Villa and his troops have arrived, there is a feeling of security such as has been wanting ever since Huerta left.

December 7, 1914.

Yesterday, the Villa organization, to which that picturesque bandit, Zapata, has, at least temporarily, become reconciled, held a military parade of all the forces at present in this neighbourhood, and the function was certainly a surprise to me as to all other foreigners who witnessed it. The men numbered well over 30,000, and, in contrast to what we have in the past been accustomed to see, they were all clean-looking well disciplined young fellows, and were all equipped with modern arms, mostly of American manufacture. Knowing what I do now, I can well understand at least one of the reasons why the American troops have evacuated Vera Cruz, for, had they remained, the day was inevitable when they would have been asked with characteristic Mexican courtesy, to "Get out or we'll put you out." President Wilson would then have found himself in the greatest fix since he perpetrated his first Mexican blunder. Whatever might have been the case last April there is no doubt but that American intervention today is out of consideration, especially in view of last week's disclosures as to the unpreparedness of the United States forces to undertake anything of a serious military campaign. It looks to me, at any rate, as if, for the balance of his term of office, President Wilson will continue to find excuses, should a serious situation arise, for crawling out of his responsibilities regarding the peace and tranquillity of the Mexican republic.

From what I saw yesterday, I am satisfied that Villa has an army that can terrorize the whole country into subjection, and that is the only kind of government that 99% of the Mexican people can appreciate or respect. This is the only army that Mexico has ever had; its efficiency is probably due to the stiffening of foreigners that I could see in each of its branches, especially in that of artillery. No wonder President Wilson intimates that he will not make any move that is in any way unfriendly to the Mexican people. Villa probably controls 100,000 men and there must be at least another hundred thousand scattered throughout the country under different chieftains or plundering for themselves independently.

Most of the mine-managers with whom I have discussed the situation hold the belief that Villa will forcibly pacify the country and then turn over everything to some one competent to arrange a system of reconstruction. Certainly he has military ability and though a most barbarous ruffian he keeps a clear head and has all his life been a total abstainer, being thus a decided contrast to Huerta and the various generals with whom that stern old warrior surrounded himself.

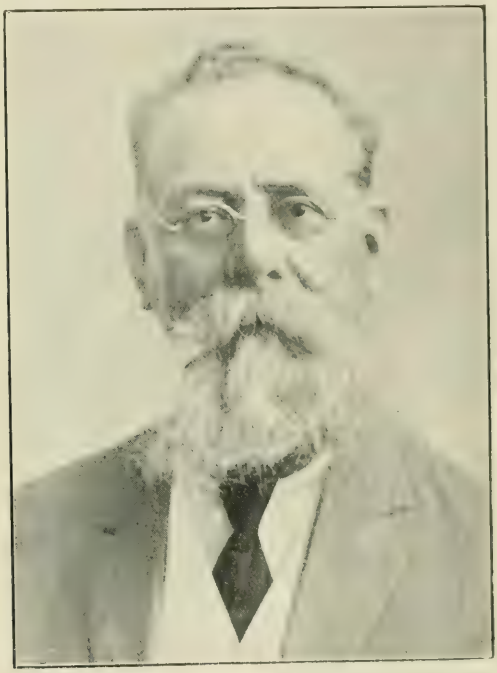
A small amount of reconstruction is already in progress. The railway from El Paso to here has been put in workable shape and a special train has been offered to the mining companies by Villa to carry and distribute dynamite, cyanide, and any other mining supplies of which there may be urgent need. A campaign is also being prepared to drive Carranza out of Vera Cruz and thus rid the country of an incorrigible scoundrel and release the large quantity of mining supplies that for many months have been held up in Mexico's chief sea-port. On the whole, therefore, the outlook for mines possessing railway facilities is better than for some time past, but for mines in less accessible localities much delay must be looked for before any improvement is apparent.

The financial standing of the country will not be so easily restored, as Carranza, among his many other schemes of rascality, completely depleted the country of every coin in circulation, commandeering the whole lot for himself, substituting pieces of pasteboard for money of small denomination and highly coloured slips of paper for bank-notes. He also had a special currency issued for expenses of his army and this I believe totalled over 300,000,000 paper pesos. The latest quotation for the Carranza paper peso at El Paso is 4 pence, which is just that much more than it is worth, for the Carranza assets are nil and subsequent governments, in justice to themselves, may repudiate the whole issue.

Then again, many enterprising Mexicans, disputing Carranza's right to monopoly, have busied themselves issuing 'bank-notes' of their own. One group of five well known people was discovered only last week with its printing-press in full operation, right in Mexico City's most fashionable suburb, and

$135,000 in paper bills ready for immediate circulation. This chaotic state of finance instead of being detrimental to, is so much to the good of, mining companies in operation, in that the bullion production has to be sold abroad for standard London or New York currency while the expense on the mines for labour and local supplies is liquidated on the basis of the comparatively worthless Mexican paper. What mining companies want is simply peace to operate and freedom from excessive taxation. Everything else can take care of itself.

General Pancho Villa.



General Venustiano Carranza.

NEW YORK

Mexico.—The old aphorism says it is always darkest just before the dawn, and the discouraging reports that emanated from Mexico during November and the early part of December seem to reflect the truth of the saying. Present reports are the most encouraging that have come from Mexico for a long time, and indicate that plans are being formulated to put the country on a stable and, it is to be hoped, permanent basis. It is reported that the present dominant party and the financial interests behind the National Railways of Mexico have come to a mutually satisfactory understanding and that a government is to be set up in which Gutierrez, Villareal, or some other suitable man is to be made President of the republic, while Villa is to be taken care of by making him generalissimo of the army, putting him forward on every possible occasion, and giving him a salary large enough to amply meet his needs; in other words, there will be a government of outward show, in which Villa will be the visible power and will keep the country quiet, and a quiet government *de facto*, which some less conspicuous man will administer, and which will permit the development of industry and the natural resources of the country. The difficulty in regard to land-holdings is to be met through the purchase of large areas by the Mexican government, which will issue bonds to make the purchase, and will then re-sell the land in small parcels to the peons on a deferred-payment basis, the payments being such that in 30 or 50 years the land will be paid for. The tenant will be secured in his possession by the proviso that the land cannot be alienated, so if the tenant gets into debt he cannot be stripped of his land, nor can he sell it to speculators. By the time this is in print the plan will probably have either succeeded or failed, but it is of great significance that it is even put forward.

If Mexico can be brought to a stable basis within the next six months the present disturbed conditions throughout the world will cause capital to turn toward Mexico, and the republic should have the greatest boom period in its history.

Zinc.—As is well known, the war in Europe has had a marked effect on the zinc industry of the United States, which had arrived at the point where its present and future output of metal was well ahead of probable demands. The smelting plants now in operation, or near completion, have a total estimated capacity of 543,000 tons of spelter per year; our production of spelter in 1913 was 418,000 tons, as compared with 345,000 tons in 1911. This rapid rate of growth of output had outstripped demands, and at the time the war broke out there were good sized stocks of metal on hand. Orders from abroad soon put these stocks on the move and spelter made a sharp advance in price. This was sustained by the Butte & Superior, the largest individual producer, having to shut-down for a couple of months on account of an accident necessitating repairs to its main working-shaft. The output of this big mine will be on the market again before this is printed and probably, unless war orders increase in size and there is a better demand for galvanized products at home, the price of spelter will thereafter tend to decline. Meanwhile there has been much interest here in the various proposals as to the disposal of Australian ores. At first it was reported that a big zinc smelter, large enough to handle the entire Australian output of concentrate, would be built in England. Americans familiar with the labour situation in England took little stock in this proposal, however. It was then rumoured that one of the big American companies would undertake the construction of a plant on the Atlantic seaboard to smelt Australian zinc ore in bond and export the spelter to Europe. This seems even more unlikely to be carried out, for the German smelters that formerly handled these ores have made the point vigorously that the war merely suspends these contracts but does not abrogate them. It is reported here that it is proposed to pass a law in England abrogating these contracts, but a situation in which an American firm undertakes to handle Australian ores, contracted to German firms, the contracts having been abrogated by English law, is scarcely likely to appeal to keen business men, and it is in the highest degree improbable that an American firm would insert its neck into this noose of litigation. If any of the smelters at present in operation in this country were at a seaport, it would be perfectly feasible to bring Australian ores to it for smelting during the period of the war, but the high freight-rates inland make this a commercial impossibility. The plant nearest to the coast is that of the New Jersey Zinc Co., at Palmerton, Pennsylvania, but as this was constructed to handle the peculiar ores from Franklin Furnace it is not available. The next nearest plants are those near Clarksburg, West Virginia, and the newly completed smelter of the American Zinc & Chemical Co., near Pittsburgh. As the latter belongs to an American organization almost identical with the German firms that have the contracts for Australian ore, it would be a simple matter to divert the Australian output to this plant, were it not for the troublesome matter of freight from Baltimore or New York to Pittsburgh and return. Meanwhile, with the Australian output out of the way, the American producers are making hay while the sun shines.

Antimony.—A metal that has attracted attention far beyond its importance, as a result of war changes, is antimony. There is no production of the metal in this country, and the market is uncertain, as it has been the custom to keep large stocks in New York and at a few other points, and numerous brokers make their living through speculative sales, while even the principal consumers take a hand in the game and speculate extensively themselves. The market had been dull and there were large stocks on hand when the war began. This had what may be called a duplex effect. Domestic buying was curtailed, so the market became duller, and some large foreign orders were placed, notably by Russian buyers, who paid a high figure for immediate shipment and sent the price of the metal skyward. The mining public learned of the advance in price and as a result became interested in the search for antimony deposits. As a matter of fact there is no possibility of making antimony mining in the United States the basis of a profitable enterprise, as the deposits here have all proved too small to be operated with our high-priced labour. Antimony mining is hardly an attractive business anywhere, as the deposits in China are so abundant and large, and the cost of labour and fuel is there so cheap that as soon as the antimony mining business there gets fully developed it will have little attraction for anyone elsewhere. The output of the Chinese mines was formerly controlled by the Cooksons, who held it down to a point where it would not affect the mar-

ket, but as the Chinese smelters could easily produce three times as much as the Cooksons would let them sell, they became restive under this arrangement, have now thrown it off, and are starting selling-agencies of their own. Probably this will have the effect of putting an end, to some extent, to the present excessive speculation in the metal, and therefore will benefit both the miner and the consumer, who have everything to lose and nothing to gain in a market that fluctuates constantly and widely.

JOHANNESBURG.

The War and Mining.—The state of rebellion and war existing in the Union of South Africa has not yet materially affected the gold-mining industry of the Rand, or, for the matter of that, the gold mines of the outside districts, such as Lydenburg and Barberton. All the Europeans that could possibly be spared have volunteered for active service against the rebels and for service in German South-West Africa, but every care has been exercised to avoid crippling the gold-mining industry. As practically the whole of the employees are known to be loyal, the rebels have given the mines a wide berth, and no fighting or disturbance has therefore taken place in the vicinity of the mines. As for the rebellion, it seems to be practically over in the Transvaal, and now that the redoubtable De Wet has been laid by the heels, it is hoped that in the Orange Free State the outbreak will also soon be suppressed.

The returns issued by the Mines Department for October show that while the gold output is normal, the production of base minerals is still below that ruling previous to the war. Even the output of coal has declined, the decrease being spread all over the various provinces of the Union. Natal, being more dependent on the bunkering and export trade than the other Provinces, has again suffered most, the Transvaal with its better local markets continuing to be the least affected. It was stated when war broke out, on the authority of Mr. Potts of the Tweefontein Collieries, that the output of coal would probably be maintained, but such has proved not to be correct; at that time the rebellion was not foreseen, nor does it seem to have been anticipated that shipping to the South African ports would show such a marked decline. The production of copper concentrate reached 2532 tons from the mines in the Cape and the Transvaal, but the shipments only amounted to 1595 tons from the Transvaal, valued at £28,840, none whatever being shipped from the Cape. Out of a total production of 197 tons of tin concentrate, only 100 tons, valued at £8338, was shipped to England, the shipments to the Straits Settlements having ceased. This shows a decline of 75% in the exports of tin, as compared with those made before the war. With regard to miscellaneous minerals, there is not much change to notice.

Technical Societies.—Attention has been again drawn to the fact that the attendance of members and the interest taken in the meetings of the different scientific and technical societies in Johannesburg are not what they should be. The principal societies are the Geological, Engineers, Chemical Metallurgical & Mining, and the Electrical Engineers. As far as the attendance of members is concerned, one meeting would easily accommodate the whole, and there seems no reason why the policy of amalgamation, recently adopted between the engineers, could not be extended with success. At the last meeting of the Geological Society only about half a dozen members attended, the papers down for discussion were passed over without discussion, and, like most meetings of this Society, the proceedings were dry and uninteresting. A similar state of affairs exists with regard to the meetings of the Institute of Engineers. The best attended meetings are those of the Chemical Metallurgical & Mining Society, but even this democratic organization has fallen on quiet times, and as all these societies are more or less connected with mining, there should be little difficulty experienced in forming one strong healthy society out of the four comparatively weak ones. A movement is even on foot to form an additional institute for the benefit of consulting engineers employed on the Rand, with the main object of protecting their interests, but at the present time there is little work for consulting engineers in private practice, and it is doubtful whether an institute would improve matters. Undoubtedly some recognized status is needed on the Rand for a consulting engineer, as at present many unsuccessful mine managers become consulting engineers, and commence a private practice as a last resource. If an institute could establish a recognized status, which is doubtful, then there might be some justification for calling one into existence.

Geological Age of Coalfields.—It is high time that some satisfactory steps were taken to settle the geological age of the productive coal measures of South Africa. It is not to the credit of South African geologists

that the views set forth in the 'Geology of South Africa' by Hatch and Corstorphine, that the South African coalfields are of Ecca age, should be allowed to prevail any longer. It seems highly probable that this erroneous view is due to Prof. Corstorphine, who at one time put forward the view at a meeting of the Geological Society of South Africa that the coalfields were of Dwyka age. This theory was advanced on the strength of a section at Vereeniging, where the coal seam occurs between two beds of conglomerate, but it was subsequently modified by adopting the view that the coalfields were of Ecca age. It was pointed out at the time by Mr. Rowland Gascoyne that this view was clearly erroneous, and that when Prof. Corstorphine had spent more time in the Transvaal, he would probably change his views. Since that time the Geological Survey has adopted the view that the age of the coalfields is more likely Lower Beaufort than Ecca age, a view which Dr. Du-Toit of the Cape Survey in his last report also supports. Even Dr. Hatch, in his address to the members of the Institution of Mining & Metallurgy, has so far apparently changed his views, as to suggest that the age of the South African productive coalfields may be after all of Beaufort age, so that Prof. Corstorphine now practically stands alone in his opinion. The point is of some importance, because, owing to the erroneous view put forward by Cape geologists, in by-gone times, many thousands of pounds have been spent in worthless prospecting for coal in the Ecca beds of the Cape Province and Natal, in the belief that the productive coalfields of the Transvaal were of Ecca and not of Beaufort age.

The New Rand.—Despite the many disappointments Mr. A. R. Sawyer has encountered in his search for a new Rand goldfield in the Orange Free State, to the immediate south of the Heidelberg goldfield, it has been decided to continue the search, and the 21st bore-hole is about to be started. So far, in the last seven or eight bore-holes, just when some indication of the whereabouts of the Main Reef series seemed possible to be ascertained, igneous matter has been encountered, necessitating the abandonment of the hole, and the selection of another site for boring. It ought to be pointed out that in other parts of the Orange Free State, similar results have attended the search for the Main Reef series, and the occurrence of these igneous flows at the exact spot where on geological grounds the Main Reef might be looked for does not appear to be a mere coincidence, but a significant fact. On the north and east of the Vredefort granite boss, Dr. Corstorphine met with a similar disappointment, and in the same way, after making a most sanguine report, and expending considerable sums in prospecting on behalf of the Consolidated Gold Fields. Others likewise have spent considerable sums in looking for a new Rand in this part of the Orange Free State, under circumstances suggesting some hope of ultimate success, but in every instance there has resulted nothing but disappointment, more especially in encountering these igneous intrusions at the exact spot where the Main Reef was expected. No one, however, has shown so much persistence as Mr. Sawyer, who on behalf of the shareholders of the New Rand Limited, has refused to allow disappointment to check his ardour, in searching for what, to others, would seem an impossible attainment.

Swaziland Coalfield.—At the last meeting of the Geological Society of South Africa, a paper was read by Mr. J. J. Garrard, on the Swaziland coalfield. This forms a connecting link between the Zululand and Komati Poort coalfields, which every now and again come into prominence and attract attention. These coalfields are in such a favourable geographical position, that, provided the coal was of suitable quality for bunkering or export purposes, they would soon revolutionize the South African coal trade. So far, however, the discovery has been of too anthracitic a nature to serve for marine or even for ordinary steam purposes, and in all probability will never come into use until the bituminous deposits of coal in South Africa have become exhausted, a state of affairs not likely to be brought about during this or the next generation. Mr. Garrard held out some hope that if attention was paid to proving the lower seams likely to be found in the Swaziland coalfield, more bituminous coal might be found. Those who have spent time and money in prospecting these lower seams have found to their cost, however, that these lower seams are very erratic in mode of occurrence, and if found good in one place, it is more than likely that it will prove impossible to trace their extension. Mr. Garrard expressed a difficulty in understanding why the upper seams of coal should be so anthracitic, and carry such a small percentage of ash, and the lower seams remain more bituminous. Considering that the whole field at one time was overlain by igneous rocks, the metamorphosis is not difficult to understand, while there is no reason

why even anthracite coals should not have in some cases a somewhat low percentage of ash, seeing that some bituminous coal seams in South Africa contain as low as from 1 to 3% of ash. With regard to the geological age of the Swaziland coalfield, Mr. Gerrard was inclined to consider it as contemporaneous with the High Veld, mentioning that it was probably of Beaufort age and not Ecca, as suggested by Mr. Anderson.

Ventilation.—In my last letter, reference was made to the important discussion revived on Mr. Pile's paper on 'Mine Ventilation on the Rand.' It will be remembered that Mr. Pile pointed out that the erection of an underground fan at a site between the Village Deep and the Village Main was much to be deprecated, because it resulted in the discharge of the whole of the return and vitiated air and dust from the Village Deep into the Village Main, an outcrop mine. Mr. James Whitehouse, the manager of the Village Deep, in taking part in the discussion, made an effort to defend the placing of the fan at this point, and pointed out that its effect upon the ventilation of the Village Deep was not as bad as represented by Mr. Pile. Mr. Whitehouse stated that there were three down-cast shafts with which to ventilate the Village Deep, and several small shafts available for up-casting the return air in the outcrop mine. These admissions seem to show that the so-called ventilation of the Village Main with return, air from the Village Deep is quite indefensible, because it ought to be practicable to arrange the ventilation of the Village Main in such a manner that fresh air could be coursed through the working-places instead of the return air from the Village Deep, as at present. As before remarked, the principal object of mine ventilation is to supply the working-levels and stopes with as fresh a supply of air as possible, and any attempt that fails in this first elementary principle is a failure.

Earth-Tremors.—There has been another serious fall of ground simultaneous with an earth-tremor, this time at the Ferreira Deep, the adjoining mine on the dip of the Village Main, where the previous mishap occurred. It will be remembered that at the Ferreira Deep, sand-filling on an extensive scale was in vogue up to about two years ago, with the object of saving the shaft and the adjoining surface, which for some time had been causing the management considerable trouble. It can only be repeated that until those responsible for the safe working of the deep mines on the Rand fully appreciate the advantages of sand-filling as a concomitant to deep mining, these disasters will continue to occur, and in all probability will increase in intensity and effect, as greater depth is reached on the Rand. The idea, which prevails among many mine-managers, that because the hanging wall is so strong and apparently so solid, it will always remain so, even after the total extraction of the lode, is a fallacy which the sooner it is removed the better it will be for all concerned.

SAN FRANCISCO.

Mexican conditions seemed to be marked by change rather than progress ; the shifts are so sudden, and show so little persistence or uniformity of trend, that we who are near the scene of activity are as much at a loss to anticipate the future as those who are farther away. Carranza was hardly in the City of Mexico until he was out again. Now he is at Vera Cruz, from which point the United States troops were withdrawn upon receipt of proper guarantees as to life and property from both Carranza and his rival Gutierrez. The latter was the provisional president chosen by the convention of military chiefs that met at Aguas Calientes. Carranza, it will be remembered, refused to retire as requested by this convention. Gutierrez is a man little known and the real force behind him is Villa, who seems to have formed a working alliance with Zapata, so that the two control most of the country. Carranza, at Vera Cruz, is directing a defensive fight ; on the northern border one of his generals, Benjamin Hill, is holding Naco against the efforts of Maytorena, the Villista governor of Sonora. Incidentally, the fighting at Naco has nearly involved the United States, since stray shots across the border have killed a number of Americans and injured others. In all 65 persons, including several troopers, are said to have been shot. American forces at Naco have been largely increased in the last few days and it is said that notice has been given to the contending Mexican generals that unless their fire be directed so as not to enter United States territory the American soldiers will shoot first and inquire afterward. Probably, however, actual fighting will not be necessary to cause our neighbours to mend their ways. It is interesting to note that even this acute cause of irritation does not lead to any general expectation of the United States 'intervening' in Mexico, and, whatever you may believe in London to be inevitable, intervention appears in the United States to be outside the domain of practical politics.

In the meantime the dominant party in Mexico is that of the peones. Both Villa and Zapata are champions of the peon and the whole practical question is whether the peones have sufficient knowledge, ability, and spirit of co-operation to organize and conduct an effective government. Most outsiders think not; this too is the opinion of thoughtful Mexicans now for one reason or another removed from the country, and the opinion is expressed by loyal Maderistas as well as Cientificos. It is fair, however, to point out that, contrary to expectations, the Zapata troops did not loot Mexico City when they took possession, though it is said that, under the impression that it was a war device of some sort, they fired on a fire-engine answering an alarum. It will also be recalled that your present correspondent travelled in October many hundred miles in Villa territory and found it all excellently policed. The leaders of the peones may have crude notions as to the righting of old wrongs, but Chihuahua has not been the scene of any local disorder since Villa obtained control of that state. Diaz was an Indian. He rose from the ranks by revolution and as he grew he made Mexico great and respected. That may prove to be the Mexican way.

Petroleum producers have as yet received no benefit and have sustained much loss from the war you and your neighbours are waging. However scarce gasoline may be in Berlin, it is selling delivered at 12 c. per gallon in San Francisco and over the whole oil-producing region there is still the cloud of over-production and surplus. Efforts are being made to bring about a better organization of the industry so as to regulate production in some effective manner. In Oklahoma a State Commission, charged with trade regulation, issued an order last autumn forbidding further drilling because any larger production at this time would merely result in waste. The order was generally obeyed; just what would happen in event that a test case were taken to the United States Supreme Court is not certain, but in any event the Oklahoma example is being much discussed in California. It is entirely possible that the legislature, which will assemble at Sacramento in January, will enact legislation lodging equivalent power in some suitable official. It could be made a measure of great benefit to the industry, but the project is distinctly revolutionary. The Federal laws governing oil-lands are still in an unsatisfactory condition, although in August much-needed remedial legislation was enacted to protect producers on land covered by various disputed withdrawals. The administration at Washington has on its programme a general leasing bill, but whether it can be carried against the opposition aroused is not certain. One notable recent change in the local situation was the leasing of 440 acres to the United Development Co. by the Southern Pacific, announced in December. The land is part of the old grant given to the railroad and over which there has been acute litigation on the basis of its being mineral, and not non-mineral as was supposed when the grant was made. Attempts were made to treat it as public land open to entry, but the United States Supreme Court decided that the 'jumpers' had no standing in court. In the meantime development had been undertaken by interests affiliated with Mackenzie & Mann, the enterprising Canadians, presumably with a view to securing an adequate supply of fuel-oil. Now that the courts have decided that the land belongs to the Southern Pacific, the latter has shown a disposition to preserve all the equities involved by executing a lease to the Mackenzie & Mann company. All of which makes for peace, which in turn makes for profitable industry.

Goldfield.—About four years ago a certain famous American pugilist was forcibly convinced, not many miles from Goldfield, that he at least could not 'come back.' He passed from the stage, but the phrase has remained, and there has been no wish dearer to the residents of Goldfield than that the famous bonanza camp should itself 'come back.' Great efforts have been made to find extensions of the Goldfield orebody, but as the months went past both gross and net have followed the inevitable downward path that mining men come to expect. Now, in the Jumbo Extension, there are signs of life and stories of a new Goldfield are in the air. Stocks that had changed hands at nominal prices shot upward, dropped, recovered a little, and gave all the signs of active manipulation. There have been rumours that the whole matter is essentially a game of some 'shorts,' and George Graham Rice, who has returned to Goldfield, has been reputed to be at the bottom. However, the matter cannot be so easily dismissed. Jumbo Extension produced $120,000 worth of ore, at a profit of $100,000, in November; that at least is substantial. No exact knowledge of the orebody is available. It is said to lie on the contact or erosion unconformity between the underlying slate and the eruptives in which the Goldfield orebodies occur. This horizon, when cut in the Goldfield Consoli-

dated mine, was not promising, but men familiar with the geology of the district have long kept it in mind as one of possible value. Whether the Jumbo Extension orebody prove really big and rich or not, it has caused a considerable revival of interest and will undoubtedly lead to exploration of the horizon mentioned.

Other discoveries of possible importance have been made in Nevada recently. One was at Tonogold, a newly named suburb of Tonopah, where gold ore has been found in the andesite. The importance of the find is still to be tested. Near Good Springs in southern Nevada, where zinc ore has been mined for some time, a most unusual dis-

INDE, IN DURANGO, MEXICO.

covery has been made, namely, orebodies in limestone containing important amounts of metallic platinum. As the occurrence is vouched for by Adolph Knopf of the U.S. Geological Survey and the assays were made by A. R. Ledoux & Co., there can be no doubt as to the essential facts. The ore masses are rich; how extensive they may be must be left for development to determine.

TORONTO.

Porcupine.—The 4-weekly statements of the Hollinger mine continue highly satisfactory to the shareholders. The latest, for the term ending November 4, shows a gross profit of $162,885 from 18,645 tons of ore averaging $14·09 per ton, the working cost being $4·48 per ton. The company has now entered upon its third dividend-paying year. The total gold production since milling was started in June 1912 to November 4 amounts to $5,891,103, and the gross profit to $3,706,734, of which $2,520,000 has been paid in dividends. With the installation of the new central air-compressing plant, underground development is being pushed more rapidly. The 800-ft. level has been reached by a winze, and a vein cut there is regarded as being probably No. 1, which has proved so productive on the upper levels, but this is as yet uncertain. The statement of the Dome for November indicates that the output is being maintained. The tonnage treated was 22,040 averaging $4·39 per ton, making $96,770. Some difficulties have been encountered in the diamond-drilling undertaken on a large scale with a view to estimating the ore reserves, the deviation of the drills from the vertical rendering results uncertain. The McKinley-Darragh, of Cobalt, has allowed its option on the Jupiter to lapse. It is understood that the prospective purchasers made a new proposition to the Jupiter directors, but it was not entertained. Work has been suspended at the mine for want of funds, though the shaft is kept unwatered. There are bonds outstanding to the amount of $50,000, and a financial re-organization will be necessary, if development is to be continued. An official statement of November operations at the McIntyre shows pro-

AMPARO MILL, JALISCO.

duction to the amount of $56,332, the extraction being 96·7%, and the working cost $4·59 per ton. The Nipissing Mining Co. has taken up its option on the Teck-Hughes in the Kirkland Lake district, although recent underground developments were not as satisfactory as was anticipated. The ore in the No. 3 vein at the 186-ft. level, though rich, proved much shorter than the shoot on the 75-ft. level. The Dome Lake is making considerable shipments of bullion. Rich ore has been disclosed by

the opening-up of No. 3 vein on the 400-ft. level. The vein is reported to be 50 in. wide with ore assaying $60 over a width of 16 inches. Among other difficulties caused by the war was a shortage of pebbles for the tube-mills. Hitherto the supply has come from Denmark, which has now, of course, been cut off. A trial is being made with pebbles from Newfoundland.

Cobalt.—The low price of silver continues to act as a check upon mining activity. The Nipissing, which has been storing its output for some weeks, recently shipped 312,233 oz. to London at 49 c. per oz. During November this company mined ore of the estimated net value of $189,029. Development at shaft No. 73 below the 4th level indicates that the ore is likely to be deeper than was expected. The five veins uncovered by hydraulic operations near Peterson lake have been worked, yielding 10,385 oz. One of them, 2 in. wide, carries 2000 oz. ore for 40 ft. The Buffalo, which largely reduced its staff some months ago, has taken on a full force of underground workers and has now 200 men employed. The low-grade mill is in operation, but the high-grade mill and refinery will remain closed until market conditions improve. The Beaver has recently made some good finds. In driving on the 460-ft. level toward an ore-shoot found on the 530-ft. level, two veins were cut, one of 3 in. wide carrying approximately 2000 oz. per ton and the other a 7-in. vein carrying 3000 oz. The shaft is down 920 ft., with a station at the 900-ft. level. The quarterly statement of the Peterson Lake shows a surplus of $208,471. Driving and cross-cutting were done during the quarter to the amount of 965 ft., and 255 ft. of rising. At the Timiskaming a strong 2-in. vein of high-grade has been found at the 750-ft. level. The mill is treating 60 to 70 tons daily, and 10 more stamps will be in operation shortly. At the Miller Lake-O'Brien in the Gowganda district, where a wages dispute took place, a strike has been averted by the action of the Conciliation Board appointed by the Department of Labour.

Nickel.—Notwithstanding the assurances of the International Nickel Co. of New Jersey that every precaution has been taken to prevent refined nickel produced from Canadian ore from reaching Germany, a great many people are not satisfied. Many journals and public men are calling on the Canadian Government to prohibit entirely the exportation of nickel in any form outside the British Empire. As there are no nickel refineries in Canada, such a drastic measure would, for the time being, at any rate, paralyse the Sudbury nickel-mining industry; the Government therefore is hardly likely to take this step unless the futility of the present arrangements to keep the metal out of the enemy's hands is clearly proved.

CAMBORNE.

East Pool.—In the last issue of the Magazine, a brief mention was made of the new discovery at the East Pool mine. Further particulars are now to hand. For some time cross-cutting northward from East Pool shaft has been in hand on the 160 and 240-fathom levels, the object being to find the faulted portion of the Great lode, which has been one of the big producers of the mine, but which was lost by faulting on the 228-fm. level. On the 160-fm. level the cross-cut intersected a lode at 500 ft., but for several reasons doubt existed as to its being the Great lode. Work on the 240-fm. cross-cut was then resumed, and at 800 ft. the same lode was intersected. At this point the lode is 30 ft. wide. Drifts east and west have been started and both are now about 50 ft. along the lode. The average assay across the working faces has been 60 lb. black tin per ton, and of course the drifts prove only a small part of the width of the lode. These results are highly encouraging, and the find is probably the most important made in Cornwall for some years.

The Sales of tin concentrate at the ticketings during 1914 amounted to 4987 tons, selling for £432,437, or an average of £86. 14s. 3d. per ton. During the previous year, 6186 tons brought £744,268 or £120. 2s. 6d. per ton, and during 1913, the sales were 6492 tons bringing £831,908 or £128. 5s. 6d. per ton. In spite of the fall in the price of tin, and the suspension of sales from July 20 to September 21, owing to the absence of a market for the metal, the results of the year's work are far from discouraging. Moreover, several of the mines, notably Dolcoath and South Crofty, have stocks of unsold black tin, waiting for more settled conditions. The only mine to show an increase during the year was East Pool, the improved position being due to the new capital introduced by Bewick, Moreing & Co. Dolcoath sold 1137 tons, East Pool 600 tons, Carn Brea & Tincroft 527 tons, Grenville 517 tons, South Crofty 466 tons, Basset 419 tons, Levant 394 tons, St. Ives Consolidated 278 tons, and West Kitty 235 tons. Wheal Kitty does not sell at the ticketings, but by private contract.

PROSPECTING FOR ALLUVIAL TIN IN NIGERIA

Government Licenses. Exploring and Prospecting. Proving by Pits and Bore-holes. Sampling. System of keeping Records.

By G. STEWART PATERSON

Introductory.—The following are a few notes resulting from my experience on the Bauchi plateau, in Northern Nigeria, written with the hope that they may be of some use to other prospectors.

I shall pass over such questions as outfit and conditions of living. The man who makes known his intentions of going to the tropics always has plenty of contradictory advice from people who have been there before. I may, however, mention Murray's book entitled ' How to live in Tropical Africa,' which contains many useful hints. On arriving in the country the prospector should at once make it his aim to obtain a good interpreter, a good cook, and a good steward-boy. All are difficult to get, particularly the first named, and it is generally necessary to put up with indifferent servants for a time. The prospector should at once tackle the language and persevere with it until he has mastered the everyday words and phrases used in connection with the work. Robinson's ' Hausa Grammar ' is of some use, but the spelling in many cases does not agree with the pronunciation on the Bauchi plateau.

The prospector is assumed to be acquainted with vanning, and the zinc-test for tin, which should always be applied in case of doubt if the sample is coarse. A new concentrate should not be trusted to the process of vanning ; but, when the value of the concentrate justifies, it should be checked by wet assay. The author has known of a concentrate containing 17% metallic tin by assay that in the hands of three expert vanners yielded only 3% metallic tin in each case ; this concentrate probably contained a hard black mineral of high specific gravity such as columbite, which obscured the cassiterite. Other minerals the presence of which makes vanning difficult are wolfram, zircon, monazite, and, to a lesser extent, rutile ; wolfram is said to be absent from Nigerian concentrates. When experience with any particular concentrate indicates that vanning will give results within 3 or 4% of the results by wet assay, the latter method can be discontinued except for checking. Only samples that give a profit-value by vanning require checking ; of these 10 to 20% should be checked by wet assay. The question of checking the original sampling of pits and bore-holes will be discussed later.

The prospector should obtain a copy of the Government mining laws in force at the time. At present the Mines Proclamation of 1913 holds good except with regard to certain royalty concessions that do not directly affect prospecting. The general procedure is to obtain a General Prospecting License, armed with which the licensee may prospect all areas open to prospecting at the time and may (1) take out Exclusive Prospecting Licenses over areas, each such area not to exceed 16 square miles. The area must conform in shape, and must be beaconed and surveyed according to the Regulations. An Exclusive Prospecting License is available for one year with right to yearly renewal for two years and under certain circumstances for a fourth year. The rent is £5 per square mile per annum for the first three years, and £12. 10s. per square mile for the fourth year. A minimum expenditure on prospecting per annum is fixed. The license gives the exclusive right to prospect the area and to take up the area or part of it as one or more mining leases. (2) He may obtain a Mining or Streaming Lease over any ground open to prospecting or any portion of an area held by the licensee under an Exclusive Prospecting License. A Mining Lease holds for 21 years and can be renewed at the end of that period ; it can also be allowed to lapse at any time on due notice being given. The rent is 5s. per acre. The area must not exceed 800 acres, and the shape and width are limited by the Regulations. A Mining Lease gives the sole right to win tin from an area. A Streaming Lease gives the right to work the stream or river-bed only. Its maximum length is one mile and the rent is £1 per 100 yards of length. There are numerous regulations for the beaconing, surveying, and working of both Mining and Streaming Leases. The occurrence of the cassiterite is such that it is rarely possible to take out a Streaming Lease.

Alluvial prospecting may be divided into

two distinct stages: firstly, prospecting as ordinarily understood, the object of which is to find sufficient indications of profitable ground to justify taking out an Exclusive Prospecting License over an area; in the second place, secondary prospecting or proving the pegged area with a view to a definite estimation of its profitable contents, and to the pegging of a Mining Lease. The second stage bears some resemblance, as regards the proving of ore, to the development of a lode mine.

Exploration. — In alluvial deposits the latest concentration of the cassiterite is in the present river-channels. Being the latest, it is generally the richest. In fact, it may be considered a rule for the Bauchi plateau that unless the river-channel contains rich concentrate the adjacent alluvial banks and flats, which have been deposited by means of the channel, will not be profitable to work. It must be noted, however, that in the Nassarawa province, at Abu and Keffi, for example, the profitable deposits are in greisen in place on a hill side, while the stream-beds are unprofitable. Such deposits are not alluvial, but the prospector must not lose sight of the possibility of their occurrence.

When looking for a new property, the prospector therefore centres his attention on the beds of the rivers and streams. He must determine their value roughly but quickly, as other prospectors may be about, his object being to peg all the valuable ground and leave the valueless to his rival. It pays sometimes to peg an area on very slight evidence, in order to prevent other people from interfering. If, however, there is no risk of this, it will pay to prospect more thoroughly before pegging on E.P.L. The work can best be done in the dry season, as the rains cease about the end of September and re-commence seriously about the end of May; the work should therefore be done between October and June. The larger the river the longer will it take to reach the dry-season level.

The presence of large boulders prevents the use of bore-holes under any circumstances. The general procedure is for a prospector to go out for the whole of the dry season. Before starting he must collect his tools, labourers, and equipment. From twenty to forty labourers will be taken, preferably the larger number, if available, and if food is abundant in the district to be visited. The labourers should be Hausa or Beri-Beris and not of other Bornu tribes or agricultural pagans from Bauchi, Kano, and the Anglo-French border, as these only work intermittently, returning to their farms periodically; also a great many of them do not understand the Hausa language, and so cause trouble to head-men and interpreters. The gang should, if possible, be under one head-man, but if this cannot be done two gangs of about 20 labourers each should be obtained, with a head-man to each gang. The choice of head-man is important, for on his energy and influence depends the working ability of the gang. All available plans of the district to be visited, and a guide, should be obtained. A good messenger is also required.

Equipment for a gang of 40 labourers, apart from personal equipment, will consist of: 30 picks, 30 shovels, 20 matchets (cutlasses), 6 axes, 60 calabashes, bags, needle, and twine, vanning-shovel, 4-lb. hammer, zinc, hydrochloric acid, and a few small crucibles, balance and weights, 100-lb. spring balance, 25-lb. spring balance, corn for labourers (if necessary), old tents for labourers (if necessary), prismatic compass 4 or 5 inches, Abney level, 100-ft. steel tape, 200-ft. steel band on reel, 5 iron rods 4 ft. by ½ in. pointed, parallel ruler, 10 or 12 in. protractor, stencil, ink, and brush, drawing-paper, tracing-cloth, pencils, pens, ink, white and red stuff for flags, small horseshoe magnet, cubic-foot measuring box, portland cement.

The picks should be large; the shovels should be all-steel, for with negro labour the breakages of wooden handles is enormous. The matchets and axes are for cutting the boundaries of an area, the axes being only necessary in country heavily wooded. The cutlasses should be of heavy pattern, with the edge on the convex side, and a good handle. This may appear an unimportant point, but it is a fact that most of the cutlasses sent to Nigeria are deplorably made and unserviceable, resulting in a great waste of time when cutting boundary-lines. Calabashes should be bought at about the New Year when they cost 6d. each. A rough chemical balance is required for weighing concentrate from samples and for vanning. It should weigh accurately to the nearest grain for vanning, and up to a pound for concentrate-samples. Two sets of weights are required. That for weighing concentrate should include 1 lb. to 0·001 lb. weight, while the other set will include 100 grains down to 1 grain. The iron rods are for use in connection with steel bands in measuring boundaries. The Government Regulations now require the location and direction beacons on an E.P.L. to be of cement, and it

is necessary to take a drum or two of this commodity.

Prospecting.—It is of course advisable to pick up as much information as possible about the districts to be visited. It is probable that most of the streams within a 30-mile radius of Naraguta have already been fairly well prospected, many of them several times over, and either pegged or turned-down. We shall assume that the prospector is prospecting new country. Every stream encountered must be tested by calabashing, and, if preliminary results are sufficiently encouraging, a rough estimate made of the value of black tin per cubic yard. It is necessary to see that the calabashers work in favourable places, such as rocky bars, rather than stretches of flat sand where it is generally impossible to get anywhere near bedrock. A rough estimate of yield is obtained by measuring the gravel in a bucket before calabashing. A labourer is told off at each working-place to keep a tally of the buckets emptied. A bucketful of gravel is weighed occasionally, the average weight obtained being applied to the total number of buckets. To obtain the weight of a cubic yard of gravel a cubical box having a volume of one cubic foot is filled and weighed at intervals. The weight of a cubic yard of gravel will be from 3000 to 4000 lb. From these data, the weight of concentrate obtained, and the percentage of black tin, we can calculate the value of the gravel in terms of black tin per cubic yard. By black tin is meant clean concentrate containing 70% metal. Thus a calabash concentrate assaying 35% would contain 50% black tin.

When good yields are obtained they should be followed first up-stream, where results are likely to improve, rather than down-stream, where the richness will decrease unless some side-stream introduces more tin. If the yields obtained are promising, one or more E.P.L. will be claimed, after which the prospector will turn his attention to fresh country.

Hydraulicking at the Juga mine.

It can be observed almost everywhere on the Bauchi plateau that the proportion of tin in the concentrate increases as the tin is followed up-stream. In fact, the source of the tin seems to be, generally speaking, in the high lands where the streams have their source. Also, it is obvious that prospecting is easier near the source than lower down, where the stream becomes large. The prospector should, therefore, if possible, start work at or within a few miles of their source. Circumstances may make the converse plan the more feasible; and if it is found in this case, when following the tin up-stream, that the yield suddenly ceases, then the tin may be found to extend from that point into a tributary stream. Tributaries should be tested. This rule does not always hold, and a case is well known of a river carrying profitable gravel, which when

followed up-stream suddenly ceased, indicating that the source of the tin had been passed.

When no maps exist of the country prospected, the prospector makes his own from a time-and-compass survey. He also makes a rough plan showing the streams examined. If an E.P.L. is taken out, a plan is necessary for the Government, and the ground must be surveyed with prismatic compass and steel band. This plan can be used to show the position and value of the points tested. The prospector always keeps on the look-out for surface indications away from any stream. Several old alluvial deposits have been found some distance from existing streams, and also valuable detrital deposits, that is, deposits of cassiterite in place resulting solely from the weathering of the country or of veins in which they originally occurred. In the best known of these detrital deposits, at Ropp, individual lumps of cassiterite weigh up to 56 pounds. Detrital deposits are usually shallow and are prospected by trenching. Old alluvial channels and terraces may be deep; then pitting will be employed.

On taking up an E.P.L. the prospector will make notes as to available water-power, labour, food, and fuel supplies, etc. These questions will be studied more fully when the property is being developed, but it is as well to take them into account from the first. A good head of water may make the difference between a profit and a loss in the working of a property.

Proving.—So far the prospector's work has resulted in the taking out of one or more E.P.L. The next stage consists in the detailed examination of these to ascertain which parts of the area are worth working, and, therefore, require a Mining Lease. No definite rule can be laid-down with regard to the degree of accuracy to which it is desirable to conform. It is generally found necessary, from a financial and market point of view, to commence production as soon as possible, so that where the stream-bed is obviously rich, a Mining Lease will be taken out at once to cover all the flats on either side of the stream. Hand-working will commence forthwith. The prospecting of these flats will then proceed at the rate demanded by the proposed plan of operations. If, on the other hand, the gravel is low-grade or waterlogged, so that it cannot be worked without the installation of a dredge, drag-line, gravel-pump, pipe-line, or other costly machinery, enough gravel must be proved of a quality to justify the expense incurred. The methods to be described will apply particularly to such areas.

Let us first consider the case of a river-channel, the richness of which we wish to determine. Where possible, small paddocks should be completely excavated to bedrock and all the gravel calabashed, or preferably sluiced, as the average calabasher loses more tin than is lost in a sluice-box. By measuring the cubic contents of the paddock and sampling the weighed concentrate, the amount of black tin per cubic yard of river-bed is obtained. If it is impossible to excavate a paddock, the bucket method may be used. But if this method is employed, one must be careful to watch the diggers and see that they do not obtain an undue proportion of concentrate from their hole and also that they do not discard large pebbles, which thus escape the measuring-bucket. Diaphragm hand-pumps will be found useful in pumping the paddock. The average depth and width of the river are obtained, and the length represented by the trial paddock. From these data the total contents of black tin are calculated. As much as 50% is often deducted as an allowance for boulders, but this deduction was applied to one successful property in Northern Nigeria on which recent working has proved that, so far, the original estimate without deduction was near the mark.

The next step is to prove alluvial flats through which the stream passes and the benches, terraces, and old river-channels within the E.P.L. There are three methods of proving these areas: pitting, drilling, and trenching. When drilling is employed, a hand-drill of the Banka type is found to be the best for the comparatively small flats found in Northern Nigeria, where the lack of depth, cost of fuel, transport, and white labour militate against the use of the Keystone type. Before describing those methods in detail, I shall consider the advantages and the disadvantages of each.

If the ground is waterlogged, or running sand is encountered, pitting and trenching are impossible; drilling must be employed. The mouth of the sand-pump belonging to a 4½-in. drill is 1½ in. diam.; if the gravel contains many pebbles exceeding this diameter, drilling becomes tedious and inaccurate, for while a pebble or boulder is being broken with the chisel, it is quite likely that concentrate is leaking into the pump from the surrounding gravel. Pitting must be employed, if possible. When the bedrock is deeper than about 25 ft., supervision of pit-sampling becomes difficult. This difficulty can be overcome by the calabashing or sluicing the whole

of the tin-bearing ground obtained, but such a method is slow and requires great watchfulness.

When the bedrock is hard, unless it is also absolutely flat, drilling will give inaccurate results owing to leakage of concentrate when one edge of the casing strikes bedrock and pumping is continued. In such case, if the ground is not waterlogged, pits must be sunk. A disadvantage of drilling is that the section of bedrock obtained is small compared with the square yard or so actually exposed in a pit; the drill-hole may strike a decomposed boulder that gives every indication of bedrock.

One engineer can sample and van the samples from 75 to 120 ft. of pits per day, depending on the hardness of the ground and the number of samples taken. If drilling is employed, he can look after two sets and the progress will vary from 60 to 200 ft. per day, depending on the hardness of the ground. In good drilling-ground, drilling is quicker than pitting.

In soft ground pitting, to a depth of 20 ft., costs about 8·5d. per foot. Drilling in the same ground will cost about 4·5d. per foot. In hard ground, such as old drift, the cost of drilling may go up to 13·0d. per foot and that of pitting to 12d. per foot. These figures include European salary and maintenance. Where the depths exceed 20 ft. the cost of pitting will rise rapidly while the cost of drilling will decrease slightly.

Sampling.—Engineers who have done a great deal of pit-sampling affirm that a cut 9 in. wide by 2 in. deep is sufficient. The 4½-inch Banka or Empire drill, having an actual external diameter of 4·7 in. when the shoe is new, gives an area of 17·3 square inches. We may assume, therefore, that, other things being equal, the drill-sample is as representative as the pit-sample. If proper precautions are taken in pits, the sampling error should not exceed 10%. Two tests made by myself prove that in compact tin-bearing gravel or sand in which the pebbles were not larger than peas even careful drilling can give most inaccurate results. In the tests the gravel obtained from a certain measured advance of the casing was measured in a box the capacity of which was half a cubic foot. Before measuring, the gravel was well shaken and drained. It has been proved by experiment at the Transvaal University College, Johannesburg, that drained sand when submitted to a pressure of 4 tons per sq. in. compresses only 5%. The gravel therefore could not have occupied originally less than 95% of its measured volume. Working on these figures it was found that in one test the amount of gravel was 85%, and in the other test 55%, in excess of the theoretical. By measuring new and worn casing-shoes, I have found that their area and therefore the volume of the sample may vary 7%. Of this no account is usually taken.

From the above considerations it is evident that though in ordinary ground drilling is cheapest it gives much less accurate results than pitting, where the depth does not exceed

The mainstay of Nigeria—The Calabasher.

20 to 25 feet. Pitting then should be adopted unless the ground is waterlogged or the depth exceeds 25 feet. The depth of gravel in Northern Nigeria varies from 5 to 60 ft., but on the average property the depth will not often exceed 25 feet.

When the prospector is engaged solely on pitting he will require from 40 to 60 labourers, according to the depth and hardness of the ground, and the amount of water to be dealt with. Gangs should be as large as possible; a good plan is to pay the head-man of a gang of 20 labourers 7s. 6d. per week, and of a gang of 15 labourers 7s. per week, adding

3d. per week for each five men in excess of 20 and not allowing any head-man to have less than 15 labourers. Equipment is almost the same as mentioned above, except that more picks and shovels are required; the picks should be of a small size and the shafts cut-down to about two feet; in addition, a dozen or so large buckets for baling with 20 ft. of $\frac{3}{4}$ in. hemp rope each, a sample-pick, and a couple of sample-tins or head-pans are required. Pits should be about $3\frac{1}{2}$ ft. in diameter. The work should be done either by contract or by task, the price or task depending on the nature and depth of the ground and on the labour market. In 1913 a usual day's task in soft ground for two labourers was the first six feet from surface; on the second day, four feet; and thereafter, three feet per day. On task-work the ordinary rate for mine labour, 9d. per day, is paid. If the bedrock is soft, the pit should be sunk into it a foot, for convenience of baling and sampling. The prospector must examine bedrock in place; cases have been known of engineers being misled by pieces of bedrock from elsewhere being dropped round the edge of the pit by labourers. He should be careful not to mistake a decomposed quartz-felspar or quartz-mica-felspar gravel for decomposed bedrock. Muscovite, the white mica, occurs frequently in such gravels; but biotite, the dark variety, seems to be confined to true bedrock or boulders; this is no doubt due to the fact that biotite is easily decomposed on disintegration, whereas muscovite is stable. Where bedrock is hard and cannot be excavated with a pick, the bottom of the pit must be cleaned thoroughly. Even so, the sampling of the last few inches of gravel is awkward and should be done by the prospector himself. Sampling is done by marking a uniform vertical cut about 9 in. wide from grass-roots to bedrock; the cut is then picked out, in sections, to a depth of one to three inches, the gravel falling into a receptacle supported by cords from above. The depth must, of course, be uniform for one particular section, but may vary in different sections. The length of section depends on the distribution of tin and gravel. Thus if the overburden were usually barren, it would only be sampled occasionally and would all be included in one sample. Tin-bearing gravel should be sampled in sections of not more than four feet. Thus in Fig. 1, AD represents the cut, AB the section of overburden sampled, BC and CD two 3-ft sections of gravel or 'wash.' Each of the samples should weigh from 30 to 40 lb. A specially intelligent labourer is employed to take samples; with a little training he will become quite expert; his pay varies from 6s. to 7s. 6d. per week. The sampling-pick Fig. 2 is a special tool; if a portable forge is available, a native blacksmith or the prospector himself can easily make it from a small pick. It

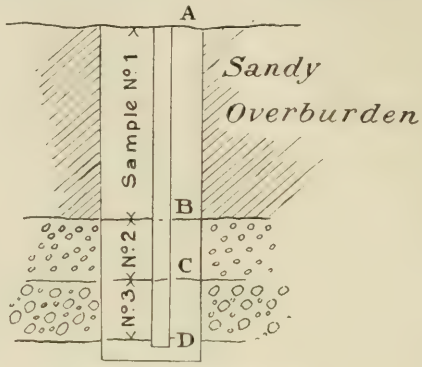


Fig. 1. Sampling Method.

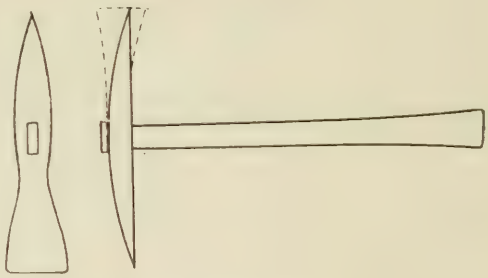


Fig. 2. Sampling-Pick.

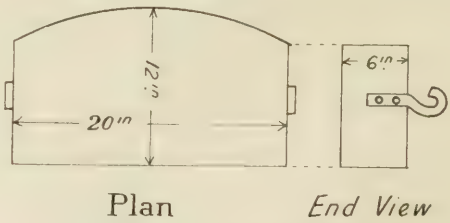


Fig. 3. Receptacle for catching the sample.

should have one limb shaped to a point while the other terminates in a flat chisel-edge about 2 in. wide, both limbs forming a right angle with the shaft. The pointed edge is used for cutting a groove each side of the cut and the chisel for cutting the actual sample between the two grooves. Some engineers prefer both edges chisel-shaped, the one being at right angles to the other, as shown by the dotted lines. For catching the sample, the best form of receptacle would be one shaped to the circumference of a pit $3\frac{1}{2}$ ft. diam., as shown in Fig. 3, with a hook at each end for rope sup-

ports. Failing this, an ordinary head-pan can be used. The sample should always be taken from the top downward. The sample is weighed and washed by calabashing. The calabasher must be expert and reliable. The prospector must always supervise the calabashing. A case is known of a prospector whose drill-samples were systematically salted by his calabashers in their endeavour, in this case unfortunate, to put their master in a good humour. There is a little loss of tin even with good calabashers. Two experiments with a good calabasher gave the following results approximately : No. 1, gravel contained 60 lb. concentrate per cubic yard. Concentrate contained 70% black tin, loss 11%, that is, a total loss of 7·7% black tin. No. 2, gravel contained 60 lb. concentrate per cubic yard. Concentrate contained 20% black tin, loss 7%, that is, a total loss of 1·4% black tin. It thus appears that, roughly, from 5 to 10% of the black tin is lost ; it would be interesting to know how these losses compare with those from sluicing ; the latter are generally supposed to be negligible.

One other factor remains before we can calculate the contents of the ground ; this is the weight of gravel per cubic yard in place. It is generally assumed to be 3000 lb., but this figure is undoubtedly low for some gravels. Theoretical considerations will indicate how the specific gravity of a quartz-felspar gravel may vary. In a fresh, undecomposed, coarse gravel the interstitial space is about 50% ; if this space is occupied with fresh sand, the interstitial space of which is 50%, the resulting unoccupied space will be 25% of the whole. The specific gravities of quartz and the felspar are practically the same and may be put at 2·6. A cubic yard of material of this specific gravity less 25% will weigh 3300 lb., which agrees fairly well with the figure 3000 lb. obtained by actual experiment. Now, if we suppose that the hard felspar decomposes into soft kaolin or clay, and is in sufficient quantity so that the resulting kaolin will fill the remaining 25% of interstices in the gravel, the weight of a cubic yard of gravel will be increased to 4400 lb., for the specific gravity of kaolin may, for this purpose, also be taken at 2·6.

In fairly loose wash, and in all wet wash, the factor should always be found by experiment ; but in hard ground, such as old drift, to determine our factor experimentally would mean excavating a deep cut, weighing accurately the material excavated, and measuring accurately the cut. It is probable that the total degree of accuracy of the final result does not warrant such nicety. The figure 3000 lb. is at any rate on the safe side, but circumstances can be imagined when it might be advisable to make accurate tests to determine this factor. The nature of the ground, both overburden and gravel, in each pit should he carefully noted. The nature of the overburden directly affects the cost of working. 10

Drilling.—The 4½ in. Banka or Empire drill is generally used. I need not describe in detail the method of operating, but will mention a few of the less obvious points. It has

The Banka Drill at work.

been proved that one European can satisfactorily superintend two drill-sets, but not more. The gang employed varies from 6 to 15 labourers per drill, including the head-man. In order to keep a hole always in advance of the casing, at least 12 labourers are required if the ground exceeds 15 feet in depth. During the past three years, labour has been scarce and one cannot hustle the native without running the risk of losing him next payday. This is particularly undesirable in drilling, as it takes the native some weeks to learn the routine. It is therefore better to have a large rather than a small gang. Drill-labourers are paid from 10d. to 12d. per day according to their efficiency ; the head-man is paid

15d. per day. For washing samples, see my remarks on pitting. In both drilling and pitting, if no suitable place for washing is nearby, a large galvanized bath, or wooden box, should be provided close to the work. This also affords a means of checking the calabashing losses. Saw-toothed casing-shoes should generally be used. They are said to yield high results in loose pebbly 'wash,' but it is probable that plain shoes would yield results equally unreliable. Plenty of spare parts are required. Two large and two small rod-wrenches should be provided with each set, or, alternately, two capstans, so that holes can always be sunk ahead of the casing. There should be at least four double rod-supports for each drill; negroes are notoriously careless with cast-iron and these tools are continually being broken. Jars should always be provided. Also spare large tongue-drills, the edge of which soon becomes dull and inefficient. There should be four sand-pumps to each set, two fitted with plain shoes and two with tongued shoes. This saves time in changing. Two spare plain shoes are required. The special lengths of casing and rod should always be used so that the operator can see at a glance the position of the bottom of the tool in relation to the bottom of the rod. The former should, of course, be always slightly above the latter. Keep all threads cleaned and oiled and never allow rods or lengths of casing to rest on the ground but always on bamboos or poles laid on the ground. There is sometimes a ledge inside the casing where the threaded part is rivetted to the tube; when the casing is withdrawn, see that the last length and this ledge are thoroughly cleaned out. These drills are not designed for, and will not stand, continuous hammering with a ram, but where the ground is tight and there is no other way of progression a wooden ram about 12 in. diam. and 3 ft. high may be used, either in connection with a shear-legs or by two labourers on the drill-platform and a 3-ft. iron bar placed in a hole drilled about 12 in. from the top of the ram. The casing should always be used even though the ground is firm enough to allow bedrock to be reached without it. Any attempt to clean out the hole without the casing will lead to inaccurate results. It is not advisable to pierce bedrock with the twist-augur or tongue-drill, for, if this is done, there will be formed a conical hole into which the concentrate will sink. When on soft bedrock, drop the sand-pump gently, in order to clean without detaching more bedrock than necessary. The hole must always be continued until tin is absent. In withdrawing and unscrewing the casing, a large chain-wrench should be used in place of the 'grip' or clutch supplied with the drill. The chain-wrench both supports the casing and can be used as a lever while the top length of casing is being unscrewed. The section of ground passed through, both overburden and gravel, as in pitting, is carefully noted.

Shallow detrital deposits are suitable for trenching. The trenches, 2 to 3 ft. wide, are cut at right angles to the general trend of the deposit, the distance between the trenches being from 100 to 900 ft., according to the size of the deposit.

Spacing of Pits and Bore-holes.—The following remarks apply equally to pits and bore-holes. Opinions vary with regard to the spacing. It is generally agreed, however, that pits should be placed along lines running at right angles to the general trend of the flat being tested, and the distance between such lines should be considerable as compared with the distance between holes along the lines. This follows from the theory that the cassiterite occurs in narrow channels running more or less parallel to the present stream-bed. In commencing work on a flat in which the distribution of the tin is unknown we may assume that it takes the form of such channels and that their width is equal to the width of the present stream-bed. The distance between holes must therefore be rather less than the latter width. If the progress of the work reveals more uniform distribution, this distance can be increased. The interval between lines of pits depends on the richness of the ground, the size of the flat, and last, but not least, the money available for prospecting. Statistics showing the relation between spacing of pits and sampling-error in alluvial flats are seldom obtainable, but in the case of dredging for gold by a company in the East the following facts were noted: River about 100 yards wide; 5 in. bore-holes; 50 ft. apart across river; lines of holes, 450 ft. apart; value of gold extracted, 7 gr. per cu. yd.; yield of paddocks worked calculated from bore-holes agreed within 10%. Based on one year's working of three 4½ cu. ft. bucket-dredges. As a general rule, a flat of 150 to 300 acres will not require more than 300 pits or bore-holes, but, of course, such a number will not be put-down unless preliminary tests are sufficiently encouraging. If the first line of holes shows nothing, the next line may be from 300 to 900 ft. away, depending on the length of the flat; on a river the distance may be even greater. On the

Specimen Page of Field-Book.

Pit No.	Depth in Feet	Nature of Ground	Weight of Sample Lb.	Lb. per Cu. Yd. Factor	Concentrate		Sn %		Black Tin (70% Sn) Lb. per Cu. Yd.
					Lb	Lb. Per Cu. Yd.	Vanning	Assay	
1	0–2	Soil	—	—	—	—	—	—	0·0
	2–10	Sand	40	3000	0·01	0·75	7	—	0·07
	10–12	Wash	30	3000	0·2	20·0	30	28	8·0
	12	Bedrock Granite							
	0–12								1·3
2									

other hand, if profitable ground is found, the lines may be closed to 200 or even 66 ft. One object of placing holes may be to ascertain the contour of bedrock with a view to the practicability of dredging, in which case holes may be spaced as close at 20 ft. in places. This object must be borne in mind.

Booking.—The field-book is of pocket size, about 8 by 5 in., bound along the short side, with printed headings and ruled columns. The printed form occupies the left-hand side of a page, the right hand being of plain or squared paper for diagrams and calculations. Check-samples can also be entered on the blank side. A booking-form suitable for pitting is given herewith. For drilling, the headings will be slightly different.

In calculating the total contents, one must be careful to include only the material that it is intended to sluice. Thus in the above table the total value of 1·3 lb. per cubic yard is based on the value of the two feet of 'wash'; the overlying sand is neglected, being of unprofitable grade. A permanent record manifold book is also kept, all essential details being entered into it. It has the same headings as the field-book except that the fourth, fifth, and sixth columns are left out. The carbon copy is sent to headquarters as required. The permanent record may, alternatively, be entered on loose sheets, which are filed; this method prevents the confusion that occurs when several different portions of the work are entered in one book, and the waste if they are entered in separate books. The field-books should be kept for checking purposes.

All pits and bore-holes are surveyed and plans are made showing them, with numbers, depth of ground, value per cubic yard in pounds of black tin, these details being indicated by the use of different colours. When surveying, each pit is marked by a peg on which its distinctive number is painted or burnt. Bore-holes are marked by a 6-ft. pole, to the top of which is attached a small board bearing the number. It is only necessary to place a pole at each end of a line of holes. The intermediate holes are marked by a long bamboo placed in the hole.

The scale of the plan depends on the distance between pits. For a spacing of 50 ft. a scale of 1 : 2000 is suitable. On all flats which it is intended to work, all bore-holes and pits are levelled. A section through each line of holes is then drawn showing surface and bedrock lines and yields. If a dredging proposition, the water-level in both wet and dry seasons should be shown. Several longitudinal sections are also drawn. These sections will prove invaluable in deciding on the method of working to be adopted.

A complete checking of returns entails the re-sampling of all pits, and in the case of bore-holes, the re-drilling of the whole flat. Where the value of the ground is on the border line between profit and loss this plan is the only safe one. If, however, the ground is of good value or, on the other hand, quite unprofitable, a preliminary check of every fifth or every tenth pit or bore-hole will be sufficient. If this preliminary checking reveals important differences, the whole of the work is re-sampled; but if the results are found to agree with those first obtained these latter are allowed to stand.

The tunnel through the Selkirk mountains, on the Canadian Pacific Railway, is being constructed in a novel manner with the object of expediting operations. As a rule such plans are confined to driving headings in each direction, and supplementing these by work from intermediate shafts. In this case, small pioneer tunnels are being driven on one side of the line of the main tunnel, and cross-cuts are run from these to the main line. Thus a large number of working points are established. The main tunnel is 10 by 7½ ft. in cross-section, and is in slate. By means of Leyner drills, 850 ft. was driven in November.

DISCUSSION

Stamp-mill Test.

The Editor:

Sir—I have read with interest Mr. King's remarks on a stamp-mill test made in Cornwall and note the claims made for the mortar-box used with the Californian type of mill. From the figures given, the 5-stamp mill shows a considerable saving in horse-power over the Nissen or single stamp for the same duty. The result obtained from the test is a complete reversal of that obtained from a similar test carried out at the City Deep mill, Johannesburg, and as the type of box used in Cornwall was practically the same as that used during the City Deep test, it would appear from the variation in the results that the conditions under which the tests were made could not have been the same. The design of the box used in Cornwall is similar to the type that is in general use in the Transvaal, and is fully described in a chapter on stamp-milling by the late G. O. Smart in 'A Text-book of Rand Metallurgical Practice'; it is illustrated on pages 52 and 53, Vol. 1, and pages 80 and 81, Vol. 2. The City Deep test formed the subject of a paper read by Mr. Peter Nissen before the Chemical & Metallurgical Society of South Africa, and the results were discussed at some length by the members. Judging from the remarks made during the discussion, it would appear that the gain in power as shown by the test was attributable to a reduction in friction owing to the smaller number of parts in the single-stamp mill, and to the circular form of the box, which distributed the feed evenly under the stamp, thereby increasing the crushing capacity per pound of falling weight.

The Nissen stamp has been in use in Rhodesia for some months and the crushing rate for the 2000-lb. stamp is 34 tons per 24 hours, when using a screen of $\frac{3}{8}$ in. mesh.

As an efficient example of milling practice, the following particulars obtained from a 25-stamp mill of the Witwatersrand type operating on banket ore in West Africa, may be of interest. The mill was erected about $2\frac{1}{2}$ years ago, and is divided into 5-stamp units. The running weight of the stamp is 1600 lb. and the number of drops 97 per minute, the length of drop $8\frac{1}{2}$ in., the average rate of crushing with a screen of $\frac{1}{4}$ in. mesh 13 tons per 24 hours. With the exception of three or four cams that failed, on account of faulty castings, during the first month and were replaced by the makers free of charge, one stem that broke two years after starting, and shoes, dies, and liners, which were worn out in the usual way, the original parts supplied at the time the mill was installed are still in use.

G. H. THURSTON.

London, December 20.

The Metal Trade.

The Editor:

Sir—Will you kindly permit me to refer through the columns of your magazine to the unsatisfactory state of affairs that exists in connection with the sale and treatment of the ores of the different metals that are produced in Australia.

The metals of which the ores exist here are (besides gold) copper, lead, silver, zinc, nickel, tungsten, tantalum, titanium, molybdenum, and tin. Of these ores all, except those of tin, have found their only market in Germany, and as a consequence of the war, the production of the metals derived therefrom has been entirely suspended for the reason that no market exists in England. It would be natural to suppose that the requirements of naval and military expenditure would have caused a great demand in England for copper, lead, zinc, tungsten, tantalum, and molybdenum, all of which can be supplied by Australia; but on the contrary, with the closing of German ports and the impossibility of trading with an enemy, the market for such ores has ceased to exist.

Let me ask: are there no smelters in England, is there no metallurgical knowledge in Wales or Cornwall competent to deal with anything more complex than tin or copper, why are such metals as lead, nickel, tungsten, tantalum, and molybdenum, all of the greatest value for warlike purposes, allowed to find their way to Germany?

There may be smelters in England competent to deal with the ores I have mentioned, but, if so, they are very diffident and difficult to find. One cannot, or could not before August last, throw a stone anywhere in the principal cities of Australia without great danger of hitting an agent for a German ore-buying firm, but I have not in 15 years met an agent for an English ore-buying or smelting firm anywhere in Australia.

Again I ask, Mr. Editor, why is this thus? Also, how long is such state of affairs to last?

LOUIS E. HORNE.

Perth, W.A., November 21, 1914.

[We discuss this subject on another page. —EDITOR].

An Appreciation.

The Editor:

Sir—In an editorial drawing attention to an article on the revolution in Mexico, you asked that other mining men should also record their experiences if they should be overtaken by a similar misfortune. Some of your readers on "the frontiers of Empire or outposts of civilization" must have received the news of the outbreak of the war in curious ways. Could you not persuade them to tell you how they first learnt it? A line in the Personal column that "Mr. Blank has arrived from Siberia, by way of Archangel" says little, but means much. The full story might be interesting.

My own are hardly worth recording, but I give them if only to lead the way. I was at La Salada in the republic of Colombia, 100 miles from a town of any importance, but luckily in telegraphic communication with Medellin. In the last days of July there came a notice from the telegraph-office saying that no cables in code could be accepted for Europe; next day that no cables could be sent to Germany, Austria, or Russia, and a day later the order was that cables must be in English, French, or Spanish; finally came a banker's telegram that drafts were unsaleable owing to the war in Europe. We had to make the best of that until the beginning of September, when the home-mail at last arrived.

It was gratifying to learn from *The Mining Magazine* that business was to proceed as usual, and in particular, that the mining industry was not, and would not be, crippled to any appreciable extent. May I tender my personal thanks for that excellent August number, which gave to men in the *monte* just the information needed regarding the probable effect of the war on our own business.

Many will join with me in hoping that the Magazine will not suffer greatly from non-renewal of subscriptions or advertisements; unless we are actually in the fighting line, mining men must have their *Mining Magazine*.

A. N. MACKAY.

West Byfleet, January 4.

Tin-Dressing in Bolivia.

The Editor:

Sir—While ignorant of the conditions actually ruling, I have often wondered why Bolivian tin shipments are of such comparatively low grade. According to H. A. Lewis in your December issue, and dealing with a district by no means remote from rail transport, the total realization charges on 60% concentrate are £36 per ton. Assuming, in the absence of information as to actual terms of sale, that the smelters' returning charge is £10. 10s. for 70% concentrate, increasing 5s. per ton for every unit below, and with tin at £130, the net proceeds in £ per ton are £1·55 multiplied by the units of metal minus 33. Therefore if, by further dressing, a product running anything less than 33% metal, or nearly half tin-stone, can be separated from the 60% concentrate now shipped, it would pay better to take it out and throw it away than leave it in to incur charges which it cannot meet. Producers cannot hope to see better prices for tin while they continue to throw it on the market below cost.

R. T. HANCOCK.

Wembley, December 22.

Analyses of Antimony were given by W. A. Cowan in a paper read before the American Institute of Metals in September last. We quote below the analyses of Cookson's brand 'C', Chinese brand carrying two overlapping circles, Hallett's brand 'H,' and Japanese brand 'MC.' Mr. Cowan gives a duplicate set of analyses, which show slight variations.

	Cookson's %	Hallett's %	Japanese %	Chinese %
Lead	0·102	0·718	0·424	0·029
Tin	trace	0·012	0·012	none
Arsenic	0·092	0·210	0·095	0·090
Bismuth	none	none	none	none
Copper	0·046	0·046	0·043	0·012
Cadmium	none	none	none	none
Iron	0·004	0·007	0·007	0·004
Zinc	0·034	0·023	0·023	0·027
Ni and Co	0·028	none	none	trace
Sulphur	0·086	0·128	0·201	0·078
Antimony*	99·608	98·856	99·195	99·760
Total	100·000	100·000	100·000	100·000

*By difference.

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	Jan. 2 1914	July 1 1914	Jan. 4* 1915
RAND:			
Bantjes	14	14	—
Brakpan	48	51	59
Central Mining (£12)	152	160	120
Cinderella	5	6	5
City & Suburban (£4)	47	52	47
City Deep	52	66	57
Consolidated Gold Fields	42	43	29
Consolidated Langlaagte	30	35	34
Consolidated Main Reef	18	18	18
Crown Mines (10s.)	125	120	91
Durban Roodepoort	16	21	20
D. Roodepoort Deep	17	17	17
East Rand Proprietary	40	33	29
Ferreira Deep	47	47	40
Geduld	21	23	20
Geldenhuis Deep	23	26	21
Heriot	52	55	52
Jupiter	5	5	40
Kleinfontein	21	24	19
Knight Central	7	8	6
Knight's Deep	30	35	25
Langlaagte Estates	18	20	17
Luipaard's Vlei	9	10	9
Main Reef West	6	7	5
Meyer & Charlton	107	115	102
Modderfontein B	82	89	85
Modderfontein, New (£4)	232	263	249
Nourse	31	27	25
Primrose	33	21	16
Rand Mines (5s.)	112	120	98
Randfontein Central	21	17	14
Robinson (£5)	53	57	40
Robinson Deep	30	33	26
Rose Deep	47	43	39
Simmer & Jack	11	12	14
Simmer Deep	2	1	1
Springs	11	11	13
Van Ryn	71	67	62
Van Ryn Deep	35	47	46
Village Deep	35	40	37
Village Main Reef	37	40	31
Witwatersrand (Knight's)	72	71	64
Witwatersrand Deep	57	48	41
Wolhuter	12	14	11
RHODESIA:			
Cam & Motor	27	19	15
Chartered	18	17	12
Eileen Alannah	12	11	7
Eldorado	13	18	14
Enterprise	13	9	5
Falcon	15	14	12
Giant	15	14	9
Globe & Phœnix (5s.)	26	32	32
Lonely Reef	43	27	24
Shamva	36	46	41
Wanderer (5s.)	1	3	—
Willoughby's (10s.)	7	7	6
OTHERS IN SOUTH AFRICA:			
De Beers (£2 10s.)	353	330	187
Glynn's Lydenburg	12	11	10
Jagersfontein	105	78	60
Premier Diamond (2s. 6d.)	190	152	82
Sheba (5s.)	5	4	4
Transvaal Gold Mining Estates	48	37	39
WEST AFRICA:			
Abbontiakoon (10s.)	7	8	9
Abosso	17	14	10
Ashanti (4s.)	17	16	14
Broomassie (10s.)	6	2	2
Prestea Block A	14	15	11
Taquah	17	15	14
WEST AUSTRALIA:			
Associated Gold Mines	8	7	5
Associated Northern Blocks	10	7	7
Bullfinch	10	6	6
Golden Horse-Shoe (£5)	52	43	54
Great Boulder Proprietary (2s.)	13	14	14
Great Boulder Perseverance	2	2	2
Great Fingall	14	9	5
Ivanhoe (£5)	58	50	47
Kalgurli	37	36	37
Sons of Gwalia	22	23	20
Yuanmi	5	3	3

	Jan. 2 1914	July 1 1914	Jan. 4* 1915
OTHERS IN AUSTRALASIA:			
Blackwater	20	16	—
Consolidated Gold Fields of N.Z.	14	13	—
Mount Boppy	16	10	11
Mount Morgan	63	52	41
Progress	9	10	—
Talisman	42	33	27
Tasmania Gold (10s.)	½	½	—
Waihi	52	42	37
Waihi Grand Junction	25	25	24
AMERICA:			
Alaska Treadwell (£5)	155	162	160
Buena Tierra	16	15	—
Butters Salvador	35	20	10
Camp Bird	11	9	6
Canadian Mining	—	—	7
Casey Cobalt	—	13	5
El Oro	13	14	10
Esperanza	19	15	9
Granville	10	10	—
Kirkland Lake Proprietary	—	74	35
Mexico Mines of El Oro	95	97	80
Oroville Dredging	15	10	10
St. John del Rey	15	15	14
Santa Gertrudis	16	11	9
Tomboy	25	22	22
Tough-Oakes	—	28	12
RUSSIA:			
Lena Goldfields	37	43	24
Orsk Priority	6	7	—
Siberian Proprietary	2	3	—
INDIA:			
Champion Reef (2s. 6d.)	10	11	12
Mysore (10s.)	97	93	86
Nundydroog (10s.)	27	27	24
Ooregum (10s.)	21	23	22
COPPER:			
Anaconda (£5)	145	126	105
Arizona (5s.)	37	36	—
Cape Copper (£2)	95	60	50
Chillagoe (10s.)	1	1	¼
Cordoba (5s.)	7	6	4
Great Cobar (£5)	16	3	4
Great Fitzroy (5s.)	3	½	½
Hampden Cloncurry	34	27	18
Kyshtim	60	55	39
Messina (5s.)	30	15	12
Mount Elliott (£5)	63	55	67
Mount Lyell	23	23	21
Rio Tinto (£5)	1370	1355	1155
Sissert	—	25	21
South American Copper (2s.)	28	22	14
Spassky	53	52	40
Tanalyk	—	78	44
Tanganyika	37	40	29
Tharsis (£2)	137	125	—
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	27	28	16
British Broken Hill	34	36	21
Broken Hill Proprietary (8s.)	35	36	31
Broken Hill Block 10 (£10)	31	32	25
Broken Hill Block 14 (25s.)	7	6	—
Broken Hill North	51	52	40
Broken Hill South	143	175	120
Sulphide Corporation (15s.)	22	26	16
Zinc Corporation (10s.)	17	19	12
ASIA:			
Burma Corporation	—	28	30
Russian Mining	—	31	10
Russo-Asiatic	72	151	84
TIN:			
NIGERIA:			
Bisichi	10	8	7
Jos (5s.)	14	5	5
Kaduna (5s.)	7	15	15
Naraguta	15	17	16
N. Nigeria Bauchi (10s.)	3	3	1
Rayfield	10	5	3
Ropp	122	100	19†
OTHER COUNTRIES:			
Aramayo Francke	33	31	22
Briseis	6	5	5
Cornwall Tailings	17	17	—
Dolcoath	16	11	11
Geevor (10s.)	10	5	2
Gopeng	27	27	24
Mawchi	20	20	4
Pahang Consolidated (5s.)	10	7	5
Renong Dredging	40	36	22
Tekka	60	55	55
Tronoh	35	26	25

* Date of re-opening of Stock Exchange; the nature of the transactions being within strict official limitations.
† Denomination of shares recently changed from £1 to 4s.

PRECIS OF TECHNOLOGY

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.]

Cyanide in America.—At the meeting of the Mining and Metallurgical Society of America held in New York on October 15, Louis Ruhl gave some information relating to the cyanide situation in America. Mr. Ruhl is connected with the American branch of the Rössler & Hasslacher Chemical Co., of Frankfurt-am-Main, Germany. Mr. Ruhl's statement was not published at the time, but appears in the bulletin of the Society dated November 30, which has only just been received. Mr. Ruhl said that his firm began the manufacture of cyanide in America in 1890, at Perth Amboy, New Jersey, making potassium cyanide of 98 to 99% guaranteed purity, by the old method from potassium ferrocyanide, using both local and foreign raw materials, the latter making it possible for the company to export cyanide made in the United States to Mexico and Central American states. It was seven years before they sold the first carload, the price being 45 cents per pound. This was not sold for gold extraction, but for the fumigation of orange trees. Among their first customers were the Mercur gold mines at Mercur, Utah, and the Brodie cyanide plant at Cripple Creek, Colo. Capt. J. R. Delamar placed the first carload order for the Nevada gold mines, at Marcus, which he had just acquired, after his failure with the Rothwell chlorination process. Delamar had come to the conclusion that cyanide was a better material to transport than chloride of lime. He started with 6 to 8 lb. of cyanide per ton of ore, the assay-value of the ore at that time being $60 in silver and $15 in gold per ton. He was anxious to recover the precious metal, and did not mind how much cyanide was used, but he soon found that he was wasting cyanide. The price at which he bought the first 100 tons was 32½ c. per lb., f. o. b. New York. Representatives of Rössler & Hasslacher tested the feed and the tailing of the Nevada gold mines and advised the neutralization of the ore with lime or caustic soda before cyaniding, which would cut the consumption of cyanide to 4 lb. per ton of ore. Several years later Delamar's manager, Hartwig A. Cohen, claimed to have reduced the consumption of cyanide to 1 lb. per ton of ore, but failed to mention that the ore had fallen in content to $10 per ton. With the enactment of the Dingley Tariff Act of 1897, reducing the rate of duty from 25 to 12½%, the company was compelled to cease the manufacture of potassium cyanide. For several years, during the period of the Transvaal war, they resorted to the importation of cyanide. In 1902 they took up the manufacture of sodium cyanide, producing it synthetically, according to Castner's process. It took 10 years to reach the high standard of sodium cyanide which they are now producing, equivalent to 128 to 130% potassium cyanide. After the enactment of the Wilson Tariff Act of 1913, putting cyanide on the free list, the output of the cyanide factory at Perth Amboy was not equal to the growing needs of the country; thus it was necessary to import cyanide to meet the increasing requirements of the United States. At the outbreak of the European war, the company immediately proceeded to reorganize its factory at Perth Amboy, by obtaining additional and sufficient supplies of raw material, so as to operate the works on a larger scale than heretofore, and thus meet the extraordinary conditions. In addition to this, arrangements had been made to procure a 1000-ton shipment of cyanide from Germany, which was to come forward on an American ship, and this would relieve the situation in Mexico, as all the cyanide they intended to import was for Mexican consumption. Being asked what protective tariff would be necessary to manufacture cyanide in the United States, Mr. Ruhl said that if, in common with other countries, the United States were on a free-trade basis, no protection would be necessary; but with a protective tariff on some things and cyanide on the free list, his company was handicapped in the cost of production by reason of the higher cost of raw material, labour, land, equipment, and capital investment compared with European conditions. The total annual consumption of cyanide in the United States was about 2000 tons, and in Mexico 5000 tons. With the enlargement of the Perth Amboy plant, which was about ready to begin operation, they would be able to supply the whole consumption of the United States, but must continue to rely on importations to supply the Mexican demand. Under the Dingley tariff of 12½%, an amount of protection with which his company was satisfied, they were able at all times to supply the whole American demand.

Radium Minerals in Australia.—The *Mining and Engineering Review* for October publishes a paper, read by S. Radcliff before the recent meeting of the British Association, describing the occurrence of radium-bearing minerals at Radium Hill, 12 miles south of Cutana, in South Australia, a station on the railway from Port Pirie to Broken Hill, and the process adopted for treating it on a commercial scale. With the exception of the deposit at Mount Painter in Flinders Range, farther north, the Radium Hill occurrence is the only one throughout Australia containing sufficient radium-bearing mineral to make active exploitation possible. Parcels of Mount Painter autunite and torbernite have been sent to Europe for treatment, but the Radium Hill concentrate is treated at Sydney by the company operating the mine. The concentrate is obtained from the ore by magnetic separators, and consists of an intimate mixture of ilmenite, rutile, carnotite, and an unidentified uranium mineral. The chemical analysis is as follows: uranoso-uranic oxide 1·6%, vanadic oxide 0·86%, oxides of thorium, cerium, lanthanum, didymium, and yttrium, 3·27%, chromium sesquioxide 0·85%, titanium oxide 45·85%, ferric oxide 17·4%, ferrous oxide 16·9%, silica 12·7%, lime 0·55%, and lead oxide 0·16%. The ratio of uranium to thorium is 100 to 1, so that the radioactivity comes from radium and not meso-thorium. The concentrate is estimated to contain one part of radium in 214,000,000. The plant treats 10 tons of concentrate per week. Here the concentrate is mixed with three times its weight of acid sulphate of soda, and fused in a reverberatory, the usual charge being half a ton of concentrate and 1½ tons of sulphate. Three charges can be treated in 24 hours. The fused product, after cooling, is crushed to 8-mesh, and fed slowly into wooden agitator-vats, into the bottom of which cold water is fed continuously. The muddy solution overflowing from the top is sent to lead-lined settling tanks where the slime is separated from the clear solution. The coarse residue, containing silica, titanium oxide, etc., at the bottom of the leaching vats is discharged to waste. The solution contains the uranium, the metals of the thorium group, and the iron, chromium, vanadium, and titanium; the slime contains the radium, barium, and lead as sulphates. Barium is not mentioned in the analysis, but it is usually present in radioactive mineral, so we presume it is in the Radium Hill ore.

The solution containing the uranium, etc., and also sodium salts is first heated with carbonate of soda which precipitates the iron, together with titanium,

chromium, vanadium, and most of the thorium group, as oxides. The uranium is afterwards precipitated with ammonia and subsequently a precipitate obtained containing 75% of uranoso-uranic oxide, U_3O_8, the remaining 25% being ferric oxide, sodium salts, and oxides of the thorium group. The slime is mixed with half its weight of strong sulphuric acid which removes iron, chromium, titanium, etc. After washing, the purified slime is boiled under pressure for two days with an excess of 20% solution of carbonate of soda, whereby silica is dissolved, and much of the lead, radium, and barium sulphates are converted to carbonates. After washing to remove soluble sulphates, the slime is fed into dilute warm hydrochloric acid. The chlorides thus produced are subsequently precipitated as sulphates. The author describes his process for further purifying the sulphates and for preparing them for the fractional-crystallization process for the separation of the radium.

Mine Timber.—As has been recorded in other parts of this Magazine, the English coal mines are likely to be inconvenienced by the scarcity of suitable timber, or pitwood, owing to the closing of the Baltic Sea during the war, and the stoppage of supplies from Russia and Sweden on which the mines have chiefly depended in the past. The Board of Agriculture appointed a committee to inquire into the situation, to ascertain how far the home forestry service could be expanded, and to investigate the possible resources in British North America and other countries oversea. Two reports were issued last month by this committee, one dealing with English supplies and the other with other possible sources. These reports contain much interesting information, and we give some of it herewith. The annual consumption of mine timber in the United Kingdom is 4½ million tons. It is estimated that of this, 700,000 tons comes from Great Britain. The stocks of timber usually held at the mines average 1 million tons. An examination of the woodlands in England, Wales, and Scotland convinced the committee that extraordinary fellings would provide 6 million tons of timber. This policy would naturally impoverish the woodlands, but would provide supplies to last for 1½ years in case sea transport was seriously interrupted. As regards foreign supplies, deliveries are still coming in normal quantities from France, and increased amounts from Norway, Spain, and Portugal. The Portuguese government has placed tracts of forest land at the disposal of English importers, and in all probability this source will afford large supplies of timber. As regards British North America, extensive forests are available in Newfoundland and the maritime provinces of Canada, but in some cases the cost would be high and in others the facilities for felling and shipment are absent. At a pinch, however, these resources would be extremely valuable.

The Board of Agriculture has issued a leaflet describing the nature of the various types of timber used, and the requirements for the mines, together with hints for growers. We quote this leaflet at some length, as we consider the information useful to those contemplating the growing of trees for mining purposes. The timbers chiefly in demand for pitwood are those combining strength with lightness. Where the roof of the mine is dangerous it is also of importance that the timbers should be of such a character that they give warning of impending movements by gradual fracture. Brittle woods are in such cases unsuitable. It has been found that seasoned props have a distinct advantage in strength and durability over unseasoned props; no timber should, in fact, be used for pit-props while it still contains sap. The absence of large knots or of even slight curves is also of importance, since when present they form points of weakness at which an otherwise sound prop readily gives way

The timber that comes from the North of Europe is either Scottish pine (redwood) or spruce (whitewood), and it reaches the mine in the form of clean, straight pieces, sawn into suitable lengths and devoid of bark. The material from France and South Europe is maritime pine. In this case the timber is shipped in sawn lengths, which are not peeled, the larger sizes being sometimes rather rough owing to their having been subjected to the process of tapping for resin. This timber is used chiefly in the South Wales coalfields. These three species represent the bulk of the timber used for mining purposes, but they are generally less esteemed than larch. Larch is stronger than any of the others, is more resistant to fungus attacks, and consequently better suited for permanent work, but is, on the other hand, more expensive. Hardwoods are also used to a small extent, but in normal times the only broad-leaved species in any considerable demand is oak. In case of a shortage, however, chestnut, beech, birch, sycamore, elm, alder, etc., will doubtless be used to a much greater extent than formerly.

The diameters of poles used as pitwood vary from 2 in. to 13 in. Although a good deal of slender timber is used in some districts and large timber in others, it may be said that as a general rule the minimum diameter of timber for which there is any considerable demand is 3 in., while it is only in exceptional localities, such as ironstone mines, that poles of a larger diameter than 6 in. are used to any great extent. Pit timber is used in lengths ranging from 1 ft. 4 in. to 18 ft. As a general rule the length varies with the diameter in the ratio of approximately one foot to one inch, but the precise dimensions depend upon the particular locality

The sizes in greatest demand in various localities are given in the leaflet. It may be stated briefly that in coal-mining districts the greatest demand is for timber 3 ft. to 6 ft. long, although there is a demand for lengths as small as 2½ ft. and as large as 7 ft.

The leaflet, in describing the methods of forestry, states that the most remunerative source of material for pitwood is from thinnings. The present rise in the price of pitwood affords an excellent opportunity for thinning woods that need treatment, but which under former conditions could not be treated at a profit. Especially is this the case with Scottish pine woods of 30 years of age and upwards, and with coppice.

Any removal of living trees from a crop tends, temporarily, to weaken the stability of the remainder against wind. The greater the exposure to wind the more gently (and the more frequently) should the crop be thinned so that the trees gradually extend their roots and become more windfirm. This remark applies especially to windward edges of exposed plantations.

Larch plantations are not thinned frequently enough, with the result that the crowns of the individual trees are reduced to very small dimensions and growth becomes very slow. The presence of 'whips' which sway in light breezes are a sure sign that a larch plantation requires thinning. Such whips are a source of danger in a plantation, since in swaying they injure the crowns and stems of adjoining trees and open the way for attacks of larch canker. They should therefore be removed, together with dead, dying, and malformed trees.

As a rule, Scottish pine plantations under 30 years of age will not yield much pitwood. A notable exception occurs with woods that have been naturally re-

generated. In such cases it is not unusual to find a number of large branching 'wolf' trees which, while unlikely ever to develop into timber trees, are spoiling young trees in their neighbourhood. The removal of wolf trees is a benefit to the remaining crop and provides a useful source of revenue. There are large areas of naturally regenerated pine in the south of England that are in need of this treatment.

Generally speaking, the same treatment applies to spruce as to Scottish pine, except that the crop requires to be kept denser throughout. Oak, beech, and chestnut coppice provide suitable pitwood. Smaller birch trees that have not yet formed rough bark may also be used.

There are three methods of treatment calling for comment: (1) Simple coppicing with storing of standards; (2) coppicing and subsequent replanting with young trees to form a high forest; (3) thinning the coppice with the object of allowing the better poles to grow into timber size. Clear cutting naturally affords the maximum amount of pitwood, but if the area cut over be large difficulties arise subsequently. The owner may not be able to replant at once; and immediate replanting is desirable if the young plants are not to be smothered by the vigorous new coppice shoots; moreover if replanting is not done, the unremunerative coppice system has to be continued for at least another rotation.

The third method of thinning the coppice and allowing it to run on for a number of years has the advantages that considerable amounts of pitwood may be obtained without clearing large areas, and that in a few years material of timber size will be obtained from the remaining crop. The process consists in reducing gradually the number of shoots on each stem so that in the course of a number of years only the best are left to grow into timber. The growth of these remaining stems after thinning is rapid, provided that the thinning is not so heavy as to isolate them.

Moist and fairly heavy soils are best suited for successful treatment. Birch or inferior timbers should be cut out where their removal will not make too great a break in the leafy canopy, and where there is an undergrowth of beech it should be carefully retained to cover the soil.

American Coal.—Bulletin 76 of the United States Bureau of Mines, written by V. H. Manning, contains a review of the coal-mining districts from which coal can be sent to sea-board for export to foreign countries. During the year 1913, there was exported 16,083,101 tons of coal, of which 11,500,000 tons went to Canada. and 450,000 to South American ports. No details of the other exports are given either in this bulletin or in the yearly volume of 'Mineral Resources.' Mr. Manning's information is given with a view to encouraging an overseas trade. The coals discussed are those suitable for industrial purposes, and do not include anthracite, which is used almost entirely for household heating. In any case foreign business is not sought. Taken by states in order of importance the chief production is in Pennsylvania, West Virginia, Illinois, Ohio, Kentucky, Alabama, Indiana, Colorado, Virginia, Wyoming, Iowa, Kansas, Tennessee, Maryland, Missouri, Oklahoma, New Mexico, Washington, Montana, Utah, Texas, Arkansas, and Michigan. The greatest coalfield stretches from Pennsylvania to Alabama, and the second covers Illinois, extending into Indiana and Kentucky. Those west of the Mississippi are of smaller extent, and with the exception of the deposits in Washington, near Seattle and Tacoma, are not situated favourably for an export trade. As is shown on the accompanying map, the leading coalfield may be divided into five sections according to convenience of shipments to tide-water. No. 1 includes the Pocahontas and New River coals which can be sent by rail to Norfolk and Newport News; No. 2 includes Maryland and Eastern Pennsylvania, with shipping ports at Baltimore and Philadelphia; No. 3 Virginia, Kentucky, and Tennessee, with ports at Norfolk, Newport News, and Charleston; No. 4 Alabama, with ports at Mobile and New Orleans; and No. 5 Western Pennsylvania coals, sent by river to New Orleans. No. 6 district covers the Illinois and Indiana coalfield, from which coal can be sent by river to New Orleans.

Mr. Manning gives details relating to the quality of the coals mined in these six districts. An average of Pocahontas coal (group 1) is: Fixed carbon 76·5%,

Coal Districts of Eastern United States.

volatile hydrocarbons 17%, ash 6·5%, sulphur 0·65%, heat value 14,700 B.T.U. New River coal is approximately of the same character. Both coals are inclined to be friable, and frequent handling reduces the proportion of lump. They are rated as first-class steam coal and as being smokeless. They also have a large application for the manufacture of metallurgical coke. The coals coming from district No. 2 are divided into two classes, one higher in volatile hydrocarbons than the other, the latter class predominating. The latter are of similar constitution to Pocahontas, but the ash content is rather higher, at 8%, so that the heating power is slightly less; on the other hand they are not so friable. The coal of higher volatile content averages 28% volatile hydrocarbons, 64% fixed carbon, and

8% ash. They are useful for coke-making and gas-making, and are largely employed for steam-raising purposes, mechanical stokers being necessary in order to decrease the amount of smoke formed. The coals from district No. 3 are higher in volatile matter than those of Nos. 1 and 2, averaging 35% hydrocarbons, 56·5% fixed carbon, and 8·5% ash. They are hard but smoky, and are used on locomotives and industrial plants. The Alabama coals, belonging to group 4, are similar to that of group 3, but are rather lower in ash, and burn well. They are extensively used in connection with the Alabama iron industry and for coke manufacture. The Western Pennsylvania coals (group 5) average 35% volatile hydrocarbons, 55·5% fixed carbon, and 9·5% ash. They are suitable for steam-raising, gas-making, and coke manufacture, and are used in the Pittsburgh manufacturing district. As they are firm and hard they stand transportation, and large consignments are sent by rail and water to industrial centres on the Great Lakes. The coals of district No. 6, Illinois and Indiana, average 38% volatile hydrocarbons, 53% fixed carbon, and 9% ash, with a heating value of 13,000 B.T.U. They are extensively used for steam-production throughout the central states. The coals of Washington (group 7) are high in volatile matter, averaging 41% hydrocarbons, 48% fixed carbon, and 11% ash, with a heating power of 13,000 B.T.U. In connection with the analyses given by Mr. Manning throughout his paper, it is to be noted that the figures relate to the averages of large shipments. Smaller shipments could be regulated so as to give better qualities.

The Nickel Industry.—Much has been heard of nickel produced from Canadian ores finding its way to Germany by way of New York, where matte produced at the Copper Cliff smelter is refined by the International Nickel Company. Light is thrown on the situation by a timely article in the *Bulletin* of the Canadian Mining Institute for December, written by Alfred Stansfield, professor of metallurgy in the McGill University. The two companies mining nickel ores at Sudbury, Ontario, produce matte on the spot, but find it to economic advantage to refine elsewhere. Any proposition to refine within the Canadian border during the war would not appeal to the producers. It has been publicly stated elsewhere by Ambrose Monell, president of the International Nickel Co., that the books of the company are regularly shown to the Canadian government, and that every care is taken not to allow the nickel produced finding its way to Germany.

The chief producers of nickel ore or matte are: (1) the Canadian Copper company at Copper Cliff, Sudbury, which during 1913 produced matte containing about 22,000 tons of nickel; (2) the Mond Nickel company at Coniston, near Sudbury, which produced during 1913 matte containing about 2600 tons of nickel; (3) Le Société le Nickel and other companies which produced in New Caledonia ores and matte containing about 8000 tons of nickel; (4) Norway which produced in 1912, 400 tons of nickel.

The matte produced in the Sudbury district contains on an average about 50% of nickel and 25% of copper. The Canadian Copper company ships its matte to Constable Hook, New Jersey, where it is refined by the International Nickel Co., which controls the Canadian company. The Mond Nickel company ships its matte to its own refinery in South Wales, near Swansea. Some of the matte and ore from New Caledonia is shipped to Havre in France and there treated for nickel. The Norwegian ore is smelted to matte at Evje and refined at Christiansand.

The world's supply of metallic nickel is produced approximately as follows: In Great Britain 2600 tons yearly and in France 1900 tons, these supplies being controlled by the Allied Powers; the United States 22,000 tons yearly, restricted as to ultimate distribution in war time by British command of the seas; in Norway 400 tons, probably available for Germany; in Prussia, 4400 available for Germany. According to 'The Mineral Industry' Vol. 22, Prussia produced 13,000 tons of nickel ore and 4400 tons of nickel in 1912. The ore, however, would not contain more than 1000 tons of nickel, so that the bulk of the 4400 tons of nickel must represent matte or ore imported from New Caledonia or the United States. Germany imported 3600 tons of nickel in 1913 and exported 1800 tons of nickel.

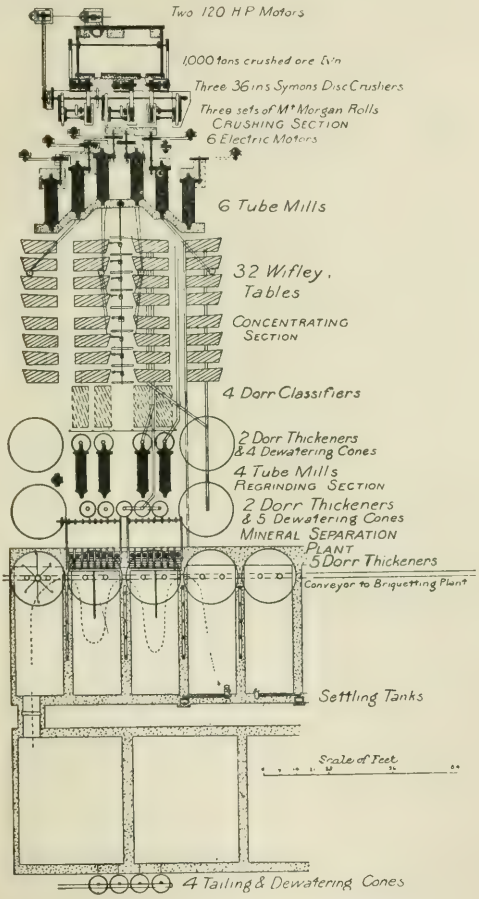
Of the 22,000 tons of nickel produced in the United States during 1913, 14,000 tons was exported, much of which went to Germany.

As regards the uses of nickel, the addition of nickel to low-carbon steel increases the elastic limit and tensile strength, without lowering materially the elongation and reduction of area, provided the addition does not exceed three or four per cent. Thus the nickel confers a combination of strength and toughness on the steel. Nickel steel has been largely used for armour plate, shells, guns and rifles, besides many other articles for naval and military use. Armour plate and shells contain chromium in addition to nickel, thus securing a greater degree of hardness. Nickel steel contains as a rule from 3 to 4% of nickel, so that each ton of nickel serves for nearly thirty tons of steel. It is estimated that two-thirds of the world's production of nickel is employed in making nickel steel, which would indicate a production of nearly 600,000 net tons of nickel steel per year. The remainder of the nickel production goes to the manufacture of alloys and electro-plating purposes.

The principal processes are shortly described by Mr. Stansfield. The matte from Copper Cliff is treated by the salt-cake process. The matte, which consists of sulphide of nickel, sulphide of copper, and a little sulphide of iron is melted with salt-cake and coke. Salt-cake is crude sodium sulphate obtained by the action of sulphuric acid on common salt, and when this is heated in admixture with coke, a sulphide of sodium is produced. The fused sulphide of sodium acts as a selective solvent, dissolving the copper sulphide and iron sulphide in preference to the nickel sulphide. In this way two products are obtained, the tops or light products consisting mostly of sodium, copper, and iron sulphides, while the bottoms or heavier product consist mostly of nickel sulphide. The separation obtained is far from perfect, and the operations must be repeated several times before the copper and nickel sulphides are completely separated. The two metals can then be obtained from their sulphides by roasting and other metallurgical processes. The matte from Coniston is treated by the Mond Nickel company in Wales by the Mond process. The matte is roasted to oxide, part of the copper is removed by means of sulphuric acid, and the residue is treated so as to convert the oxide of nickel to the metallic state. It is then treated with carbon monoxide gas which combines with the nickel forming a volatile, poisonous compound, nickel carbonyl, from which the nickel is recovered in a pure condition. While the main principles of these two processes are well known, the details are kept secret. The operations involved are more numerous than has been indicated above and require, especially perhaps in the Mond process, highly skilled scientific direction and great accuracy of detail. The matte from New Cale-

donia does not contain any copper and its treatment is therefore comparatively simple, as it is the need of separating the nickel and the copper, contained in the Canadian mattes, that entails the use of the salt-cake or the Mond process. The Norwegian nickel is obtained from the matte by the Hybinette process in which the nickel is separated from admixed metals such as copper by electrolysis in a sulphate solution.

Concentration at Mount Morgan.—The *Queensland Government Mining Journal* for November contains an illustrated article on the new smelting and concentration plant at the Mount Morgan gold-copper mine, written from notes supplied by the manager, Benjamin Magnus. The accompanying flow-sheet



FLOW-SHEET OF MOUNT MORGAN CONCENTRATOR.

shows the arrangement of the new concentrator, which has been running continuously since the beginning of July. The capacity, 500 tons per day, has not yet been reached, the amount treated during the last four-weekly period recorded having been 6785 tons. The ore treated belongs to the second and third grades, and is high in silica. Originally the intention was to smelt it direct, in combination with the low-grade gold-copper ore from the Many Peaks mine, the expected losses in water-concentration indicating that this plan was the best. However, the cost of smelting and the adaptability of the Minerals Separation flotation process have, between them, caused this plan to be altered, with the result that the concentrator has been installed. After being reduced in gyratory and jaw breakers to $2\frac{1}{2}$ in., the ore is sent to Symons disc crushers, in which it is reduced to $\frac{3}{4}$ in., then to rolls, and subsequently to 6 Krupp tube-mills, which reduce it to 80-mesh. The pulp is passed over 32 Wilfleys, the tailing from which is separated into sand and slime, the former re-ground, and the whole tailing product sent to Minerals Separation plant. Details of the results may be expected when the concentrator is in full working order.

Zirconia as a Refractory.—In *Metallurgical and Chemical Engineering* for December, H. Conrad Meyer, of the Foote Mineral Co., gives some information relating to the use of zirconia as a refractory. In the text-books it is usually stated that the mineral zircon, the silicate of zirconium, is the only source of the metal or of its oxide, zirconia. Mr. Meyer, however, states that the natural oxide is comparatively abundant. The average content of this mineral is 84% of pure oxide, with 8% of silica, and 3% of iron oxide. Apparently he refers to the mineral baddeleyite which is found in Brazil, Ceylon, and Montana. The mineral can be used without purification for the manufacture of refractory brick, though the pure oxide gives slightly better results. The cost of producing pure oxide is considerable, but recently a cheap process has been introduced for removing the iron. Crude zirconia has a high melting point, 3200 to 3600° F. It has a low coefficient of expansion, and low thermal conductivity, the latter being half that of ordinary fire-brick. It offers high resistance to copper, brass, steel, tungsten, etc., but is attacked by fluorine compounds and acid sulphates. Its introduction to commercial chemistry was due to Welsbach who used it as a glowing agent instead of lime, before he found that thoria would glow equally well at a lower temperature. It is used also in the Nernst electric lamp. As a refractory it has many possible applications.

Nickel Arsenides as Precipitants of Silver.—A paper by Chase Palmer and Edson S. Bastin, appearing in *Economic Geology* for March 1913, described the precipitation of silver from sulphate solutions by arsenides and sulphides, particularly arsenide of nickel, niccolite. These reactions were studied with a view to explaining particularly the occurrence of native silver with nickel arsenides. The studies in this direction have been continued, and Mr. Palmer contributes a second paper to *Economic Geology*, October 1914, describing the action of various nickel arsenides. Experiments with niccolite (NiAs) show that it is attacked by dilute solutions of silver sulphate with the formation of nickel sulphate and arsenious acid, the silver being precipitated in metallic form. Other minerals containing nickel and arsenic were tried also. One of the specimens was supplied by a dealer as cloanthite ($NiAs_2$) from Mansfeld, Germany, but the experiments proved its composition to be Ni_4As_3. No mineral of this composition is mentioned in the text-books, but it happened that two communications to the technical press were made shortly before the time that the author was conducting his experiments. One was by F. Grünling in *Centralblatt für Mineralogie* for April 15, 1913, describing a new mineral discovered by W. Maucher at Eisleben, and named maucherite. This mineral is silver-white in colour and its composition was given as Ni_3As_2. The other was by T. L. Walker, who in the *American Journal of Science*, Vol. 37 p. 170, described temiskamite, Ni_4As_3, occurring in Ontario. Mr. Palmer proceeded to experiment with specimens of these minerals as well as that which he had received

from Mansfeld, and found that they had the same faculty for precipitating silver from sulphate solutions. In further investigations with regard to the action of sulpharsenides, the author finds that the sulphur tends to prevent the oxidation of the arsenic by the silver solution, so that the precipitation of silver in nature is more likely to be due to the arsenides than sulpharsenides.

Tin Deposits in Pahang.—In the *Monthly Journal* of the Chamber of Mines of Western Australia for October, J. T. Marriner describes the mines belonging to the Pahang Corporation, with details of the ore deposits and of the method of mining. The mines are 22 miles inland from the port of Kuantan, in the state of Pahang, on the east side of the Malay Peninsula. They are the only lode-tin mines in the Malay worked by an English company. As we recorded in our issue of October, some lode-tin is mined in the limestone of the Kinta district by local owners, but the Pahang deposits are of different type, being associated with granite and slate, thus resembling lode-tin deposits in Cornwall and other parts of the world. In our department devoted to Company Reports, we give particulars of the work done by the Pahang Corporation. We need only say here that the crushing capacity is 15,000 tons per month and the average output of tin concentrate 240 tons per month. At the most important of the mines of this company, Willink's, the deposits follow a complicated series of fissures, and were worked first on the outcrops on the side of a hill, into which the lodes pass in an eastward direction. The country rock is slate in the neighbourhood of granite. The mine contains a number of approximately parallel lodes running east and west. Three well defined faults have broken the continuity of these lodes. In addition there are numerous small fissure veins running in various directions, disturbing the main lodes and determining the limits of the smaller ore-shoots, but carrying little or no tin. The contact of the slate and granite is exposed in Willink's shaft between the 300 and 400-ft. levels, and in several places in the west and northwest of the workings. As far as is known, the lodes do not continue into the granite for more than a few feet, and then only as small veins, with the cassiterite occurring as coarse crystals of resin-brown colour. The contact of the granite and slate does not show the gradation of absorption of the slate, usually extending for several feet in similar formations in other parts of the peninsula, but consists of a clearly defined though irregular separation. The lodes are approximately at right angles to the granite in the majority of cases, and the best ore is found from 100 to 200 ft. from it where the lodes are wider.

The three faults above-mentioned are known as the southeast slide or lode, the northeast fault, and Bell's fault. The chief lodes are Willink's Main, Willink's South, Nicholson's, Nicholson's East, and Bell's North. The two shafts are known as Willink's and Nicholson's. The workings are down to the 600-ft. level.

The faults have a southeasterly strike and dip slightly to the northeast. They extend from the upper levels to the bottom of the mine, and caused the displacement of the lodes to the north. The southeast slide carries ore and is included under the heading of lodes. Its strike is S. 70° E, and its dip 60° northeast. The northeast slide is, for the most part, barren, but a patch of ore was found at one level close to the cross lode. Its strike is S. 50° E., and its dip 85° northeast. The large amount of included breccia, over 3 ft. wide in places, and the striation of the walls afford evidence of considerable rock movement. It carries some water in the lower levels. Bell's fault carries some quartz, but is otherwise similar to the northeast fault.

Development indicates that Willink's South and Willink's Main lodes are portions of what was originally one lode, but the portion termed the Main lode has been thrown to the north and west by the southeast slide. The result is that, in depth, Willink's Main lode appears to die out gradually, while Willink's South lode gains in length and importance. At the 600-ft. level Willink's Main lode is practically non-existent. The exact relations of the other lodes are unknown. It is almost certain that the fissures were caused by the same disturbing force, but these lodes are probably not, as originally supposed, the thrown portions of an adjacent one.

In addition to tin oxide, the lodes carry iron and copper sulphides, mispickel, blende, and galena, the last-named infrequently. Wolfram has been seen, but is of rare occurrence.

The South lode, of which the productive portion is at the southwestern end of the mine, has a dip of about 83° to the north, and is usually from 2 to 4 ft. in width in the upper levels. It has, however, been mined for a width of from 10 to 15 ft. in the lower levels. The ore-shoots vary in length, from 150 to 500 ft. Numerous branches are found on the north side of the lode, and some of these have been profitably mined. These branches have a flat pitch to the north, and are usually found to contain ore of limited extent, but of high tin-content. They are probably the result of the southeast slide splitting and meeting the South lode at an angle corresponding to the dip of the veins.

The southeast slide has an ore-shoot, which, so far as has been ascertained, varies in length from 200 to 400 ft., and has been mined between the 120 and 302-ft. levels. This lode is remarkably uniform in character, and is composed of a band of quartz and calcite from 1 to 2 ft. wide, containing numerous vughs and a narrow band of pulverized rock breccia. Tin oxide is found in the quartz, and is usually of a light brown or creamy colour and fairly disseminated. A flow of carbonic acid gas was observed in a drift on this slide at the 240-ft. level; it has also been observed bubbling through the water in the bottom levels on the Willink's lode.

Willink's Main lode in the upper levels is characterized by the comparative scarcity of quartz and calcite; it usually has a central rib of tin oxide with sulphides; the oxide is sometimes nearly pure and over an inch thick. Branches diverge from the main fissure, but die out within a distance of 10 to 15 ft. This peculiar structure accounts for the great width of many of the old stopes on this lode. The length of the ore-shoot is from 300 to 400 ft. in the upper levels. A remarkable shoot of ore was discovered at the 500-ft. level in May, 1912, when driving a cross-cut south from Nicholson's shaft. The southeast slide, which, at this point, dips to the northeast at an angle of about 40°, forms the eastern boundary of the shoot and cuts off the vein completely in section 10 east. Westward from this point, development work has proved the continuity of the ore for a distance of about 800 ft., of which 400 ft. gave an average assay-value of 7% tin oxide over a width of 5 ft. In the richer zone, the vein was composed of a central rib of fairly pure cassiterite of a brownish colour, from 6 to 12 in. thick, and on either side bands of quartz and arsenical pyrite or of a mixture of the latter with tin oxide. Cross-cuts show the lode to be profitable in some places for a width of 25 ft.

Some workings on Nicholson's lode are in the higher

levels where the ore occurs usually in one of two forms: (*a*) A matrix of finely disseminated tin oxide and iron oxide containing strings of pure crystallized cassiterite, the whole having a decidedly reddish tinge: (*b*) Soft white chloritic clay, resembling kaolin, and containing loose grains of coarse brownish cassiterite. The largest of the old Chinese workings is situated on this lode. Another exceptionally rich deposit occurred in Nicholson's lode. The vein was practically devoid of sulphides and contained little or no gangue. It is expected that Nicholson's, Nicholson's East, and Bell's North lodes will come closer to or connect with Willink's South lode in depth.

CURRENT LITERATURE

[*Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.*]

Substitutes for Mine Timbers. — At the December meeting of the Midland Counties Institution of Engineers, W. H. Hepplewhite read a paper describing steel substitutes for the timbers now used in British coal mines.

Ore Dryer.—*Engineering* for December 25 describes the Ruggles dryer which is used for drying ore, cement, and other materials.

Jigs in Gold-Dredging.—In the *Mining and Scientific Press* for November 28, James W. Neill describes the method of recovering black-sand by means of jigs.

Law of Crushing.—In the *Engineering and Mining Journal* for November 21, H. Stadler commences an article reviewing the laws of crushing as applied to ores.

Estimation of Gold in Blister Copper.—In the *Mining and Engineering Review* for November, K. Prout Webb, chemist to the Hampden Cloncurry mines, describes the sulphur method of estimating gold in blister copper, matte, and ore.

Cyanidation in Colorado.—In the *Mining and Scientific Press* for November 28, Jackson A. Pearce describes the method of cyaniding adopted for treating Clear Creek and Gilpin County sulphide ores, and gives particulars of the Argo plant.

Lead Smelting.—The *Engineering and Mining Journal* for November 21 describes the remodelled lead-smelting plant of the St. Joseph Lead Company, Missouri. This plant has been built to smelt sintered lead concentrate.

Zinc Smelting.—In the *Engineering and Mining Journal* for December 5, W. R. Ingalls describes the zinc-smelting plant erected at Langeloth, near Pittsburg, Pennsylvania, by the American Metal Company.

Smelter-Fume Troubles.—The *Mining and Scientific Press* for December 19 prints the report of the Commission appointed to investigate the smelter-fume nuisance alleged by the town of Benicia and the farmers to be caused by the Selby lead-smelter on San Francisco Bay. The report holds that since the installation of the bag-house in April last, the troubles arising from lead-fume have disappeared.

Ferro-Silicon.—The *Iron & Coal Trades Review* for December 11 and 18 contains a paper by John Harden describing the manufacture and properties of ferro-silicon.

Geology of Belgian Congo.—In *Economic Geology* for October, S. H. Ball and M. K. Shaler describe the geology of the Belgian Congo. This paper covers much the same ground as that written by the authors for this Magazine and published in our issue of July last, but with the geological features accentuated.

Copper Mining at Lake Superior.—In the *Mining and Scientific Press* for December 5, Thomas T. Read commences a series of articles on copper mining in the Lake Superior district. During the last few years many changes have been made in mining and concentration methods.

Platinum Deposits in Germany.—The *Mining and Scientific Press* for December 5 contains a translation by F. Sommer Schmidt of P. Krusch's paper read before the German Metallurgical Society, describing the occurrence of lode-platinum in Silurian rocks in Westphalia, Germany.

Wolfram, Molybdenite, and Bismuth in Queensland.—The *Queensland Government Mining Journal* for November contains the first part of a paper by L. C. Ball on the wolfram, molybdenite, and bismuth mines at Bamford, between Herberton and Chillagoe, North Queensland.

Edna May Mine.—The *Mining and Engineering Review* for November describes the Edna May gold mine at Westonia, near Carrabin, West Australia.

Tin in China.—The November *Bulletin* of the American Institute of Mining Engineers contains a paper by M. B. Yung describing tin deposits, worked by local Chinese, in the Fu Chuan district, north of Canton, China.

Coal in Carboniferous Limestone.—The North of England Institute of Mining and Mechanical Engineers has issued a voluminous report on the coal deposits found in the mountain limestone in the North of England.

Braden Hydro-electric Power.—*The Engineer* for December 25 contains a paper by R. E. Graham Clark describing the hydro-electric power plant of the Braden Copper Co., Chile.

NEW BOOKS

Through Unknown Nigeria. By John R, Raphael. Octavo, paper covers, 360 pages, with many illustrations. London: Werner Laurie Ltd. Price 5s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This book gives the record of a journalist's travels through a part of West Africa that is attractive at the present time to the mining man. The observations may not appear profound to the experienced geographer or ethnologist, but the author gives us sufficient details that have come under his own notice to make the pages interesting. His descriptions of life and customs, and of the methods of government and taxation are useful, and serve to prove that English rule is not born of conquest but of a desire to guarantee security to the native inhabitants and to the protectors. The government of the country is done through, and by, the natives themselves. A handful of white men govern 10,000,000 inhabitants without the slightest fuss, humanely and efficiently. Prisoners in gaol are taught trades, and others help to build railways, the desire being to suggest the greater profitableness of honest work. References are made to tin-mining in Chapter 23, which gives an outline of the beginnings of the industry. It was in 1905 that the first systematic work was done, by Mr. H. W. Laws, at Naraguta, and in 1910 the Bauchi plateau became famous. In the next chapter the administration of the mining districts is sketched. The chaotic condition of the Mines Department is attributed to its being under-manned, but the author is evidently not in a position to make discriminating criticism. The photographs with which the book is illustrated are excellent. To sum up, the book is interesting without being of great importance.

COMPANY REPORTS

St. John del Rey.—The interim report, for the six months ended August 31, of this company, working the Morro Velho gold mine in the state of Minas Geraes, Brazil, shows that 99,503 tons of ore was raised, and 95,000 tons sent to the 130-stamp mill, for a yield of gold worth £225,514, or 47s. 5d. per ton. The royalty was £12,876, and the working cost £154,064, making a total working expenditure of £166,940, or 35s. 2d. per ton. The sum of £20,000 has been allocated to capital expenditure, £576 paid as debenture interest, £5000 as dividend on the 100,000 preference shares of £1 each and £20,584 on the ordinary shares, being at the rate of 7½% per year. The labour shortage, from which the mine has suffered during the past year or more, has disappeared, and the full complement of men is now at work. The shaft 'G' has been sunk 1200 ft. below horizon 16 from which it started, and has reached the level of horizon 20 at 5800 ft. below outcrop vertically. The orebody is to be developed simultaneously on horizons 19 and 20. On horizon 18, 5200 ft. below outcrop, the orebody has been proved to be 1150 ft. long, but its average width has not yet been ascertained. As far as is yet known, the amount and assay-value of the ore on this horizon are equal to that on the horizons above. The working cost has been only slightly increased by the higher rates for freight and insurance caused by the war.

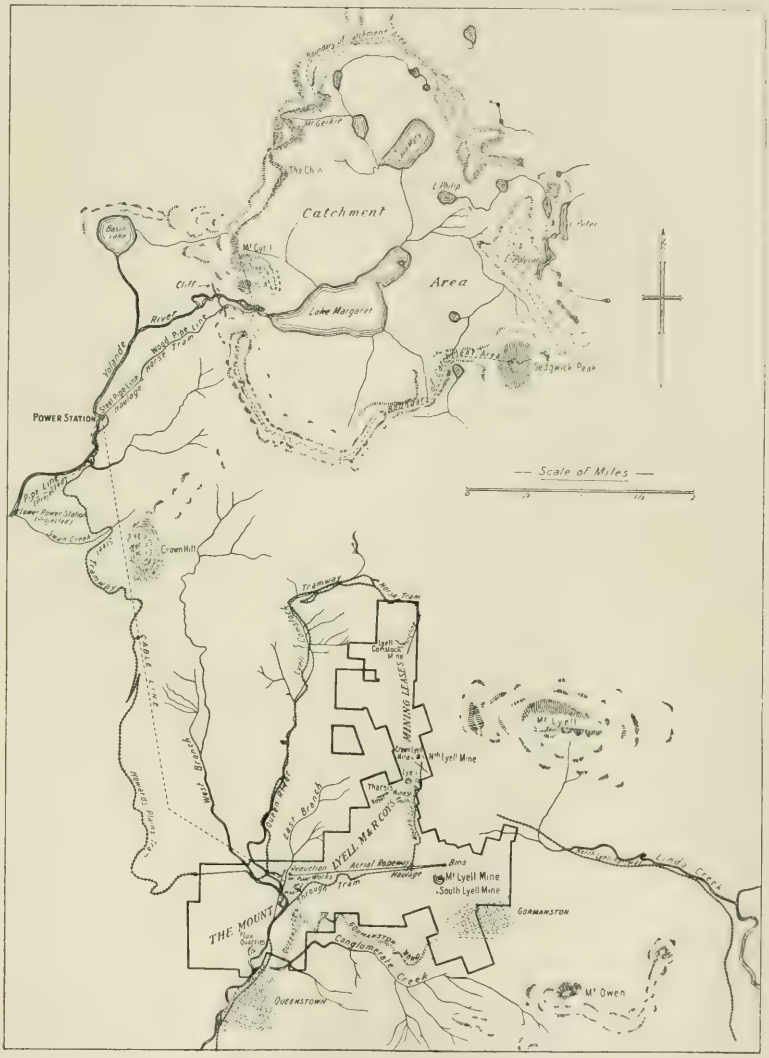
Ashanti Goldfields.—This company was formed in 1897 to acquire, from the Côte D'Or Company, gold-mining properties that had previously been worked superficially by native owners, situated at Obuasi, in the Gold Coast colony, West Africa. We have on several occasions, notably in our issue of January 1913, given historical accounts of this company. The report for the year ended June 30 last shows that 117,867 tons of ore was treated for a yield of 101,579 oz. gold, and that 16,625 tons of old tailing yielded 2260 oz. gold. Of the ore treated, 52,539 tons came from the Obuasi shoot, 15,268 tons from the main workings of the Ashanti mine, 26,695 tons from the Ayeinm mine, and 19,706 tons from other properties. The income from the sale of gold was £447,947. The working cost was £213,257, cost of development £45,558, government royalty £22,164, and allowance for depreciation £21,237, leaving a profit of £145,731. The dividends absorbed £147,326, being at the rate of 68¾%. As compared with the previous year, the ore treated was 30,500 tons less, the total yield 6380 oz. less, and the dividends £40,500 less. The decrease in the amount of ore mined was foreshadowed by W. R. Feldtmann, the consulting engineer, a year ago, and was due partly to labour shortage and partly to practical difficulties in connection with stoping. The larger proportion of ore extracted from the Obuasi shoot caused an increase in the gold returns. The developments during the year have added to the reserve, for which the figures are: Ashanti main workings 34,100 tons averaging 21·08 dwt., Obuasi shoot 213,400 tons averaging 27·3 dwt., Ayeinm 120,000 tons averaging 10 dwt., Justice's 65,000 tons averaging 11 dwt., total 432,500 tons averaging 19·5 dwt. The increase in tonnage is chiefly in the Obuasi shoot, though the content of the reserve in that shoot is 4 dwt. less than a year ago. The reserve will, it is estimated, provide profits at the rate of £150,000 per year for four years.

Oroville Dredging.—This company was formed in 1909 to acquire the shares of an American company of the same name which directs a group of gold-dredging operations in California. A few months later a gold-gravel property was acquired at Pato, Colombia, and a separate English company formed to work it, the capital necessary being supplied out of the profits of the California operations. In January 1914, additional land adjoining the Pato was acquired and a company called the Nechi Mines (Colombia) Ld. formed to work it. The report of the Oroville Dredging company now issued covers the 15 months ended September 30, and that of the American company the 12 months ended July 31. During the 12 months, two dredges were continually at work, and a third for five months, after which it was dismantled. During this time, 2,897,557 cu. yd. of gravel was treated for a yield of $251,598, or 8·68 cents per yard, at a cost of $117,246, or 4·04 c. per yd. After payment of administration expenses, taxes, etc., the profit was $116,804, out of which $42,900 has been written off for the dismantlement of dredges. A dividend of $87,242 was paid by the American company, and since the close of the financial year another dividend of like amount, out of the balance in hand $389,306. The English company has distributed £31,482 as dividend, being at the rate of 10%. The Pato dredge started work at the end of 1912 and during the two years to December 8, 1914, the gold won was $67,538 from 474,428 cu. yd. during the period of digging toward the tested area, and $848,114 from 1,400,340 cu. yd. since then. W. A. Prichard has recently made an examination of this property and reports that an additional 528 acres may be added to the 310 acres originally tested with approximately the same content. It will be noted that the yield of the tested ground already treated was 60 cents per cubic yard.

Champion Reef.—This company was formed in 1889 by John Taylor & Sons to develop the lode beyond the northern boundary of the Mysore mine, Kolar, India. The prosperity of the enterprise continuously expanded until 1905, since when the grade of the ore milled has been much lower, averaging 9 dwt. per ton, as compared with 1 oz. in 1905 and 1⅛ oz. in 1900. The report for the year ended September 30 shows that the output and profits are still slightly increasing as compared with the results in 1909, when the conditions were the least favourable during the whole life of the mine. The amount of ore milled was 216,943 tons, and 334,494 tons of tailing was cyanided, the total yield of gold being 124,497 oz. worth £527,500. The yield per ton below the stamps was 9 dwt. and from the tailing 1·6 dwt. The working cost was £302,011 or 27s. 10d. per ton, and £29,389 was paid as royalty. In addition £15,000 was written off for depreciation of plant, £21,927 written off shaft-sinking account, and £15,000 placed to reserve. The shareholders received £138,666, being at the rate of 53⅓%, as compared with 160% in 1905 and 20% in 1909. The results are particularly gratifying when it is remembered that for four months, March to June, the supply of electric power was seriously restricted owing to the drought and the consequent diminution of flow at the Cauvery Falls. To provide against such restriction in the future, and also to extend the installation, the Mysore government is building a dam on the river. The development done during the year amounted to 17,334 ft., and the amount of ore disclosed has been large, the reserve increasing during the year by 73,000 tons and standing on September 30 at 477,000 tons, In the deepest part of the mine between Glen and Garland's shaft, the lowest five levels, the 41st to 45th, have all been in ore of excellent grade. The Circular shaft has been completed to 3861 ft. vertical, and cross-cuts driven to the 41st and 42nd levels. The steel guides should be completed early in 1915. The tube-mills for re-grinding the coarse sand before cyaniding started in September.

Air-blasts have been less frequent lately, owing to the improved method of stope-filling adopted, while in the most dangerous part, from the 19th to the 25th levels, operations have been suspended.

Mount Lyell Mining & Railway.—The report of this company, operating the Mount Lyell copper mines in Tasmania, for the half-year ended September 30 shows that 104,711 tons from the Mount Lyell mine, averaging 0·47% copper, 1·71 oz. silver, and 0·9 dwt. gold, was sent to the smelter, together with 65,604 tons from the North Lyell mine averaging 6·05% copper, 1·14 oz. silver, and 0·1 dwt. gold. The blister copper amounted to 3911 tons containing 3864 tons of copper, 230,592 oz. silver, and 5280 oz. gold. The blister was refined in New South Wales by the Electrolytic Refining Co. of Australia. The accounts show that 821 tons of copper left unsold at the beginning of the half-year was subsequently sold at an average price of £63. 13s. 11d. per ton. Of the copper produced during the half-year 1547 tons was sold at an average price of £52. 18s., leaving 2317 tons unsold. Since the accounts were rendered, 750 tons has been sold. The ore reserve is estimated at 1,991,789 tons in the Mount Lyell mine averaging 0·53% copper, 1·96 oz. silver, and 0·55 dwt. gold, and 959,832 tons in the North Lyell averaging 6% copper, 1·33 oz. silver, and 0·1 dwt. gold. On the outbreak of the war 157 of the miners volunteered for service. The development was suspended, but production proceeded. The hydro-electric installation at Lake Margaret has been completed, and the power will be available almost immediately. Plans have been completed for a flotation plant with a capacity of 600 tons per week, but its erection is postponed for the present. The profit for the half-year was £29,317; a dividend of £64,459 was distributed on June 15.



MAP SHOWING THE MOUNT LYELL CO.'S MINES AND HYDRO-ELECTRIC POWER INSTALLATION.

Sulphide Corporation.—We have on several occasions recorded the history of this company, which operates the Central mine at Broken Hill, New South Wales. The report for the year ended June 30 shows that 209,074 tons of ore, averaging 14·4% lead, 16·9% zinc, and 12·1 oz. silver, was raised and sent to the mill, where 31,942 tons of lead concentrate was produced, averaging 66·8% lead, 6·4% zinc, and 33·6 oz. silver per ton. The tailing, averaging 5% lead, 18·8% zinc, and 8·2 oz. silver, was treated in the flotation plant, and 69,216 tons of concentrate was produced, averaging 43·7% zinc, 10·1% lead, and 17·3 oz. silver. This concentrate was subsequently treated on tables for the separation of lead, and 64,798 tons of zinc concentrate, averaging 46% zinc, 8·3% lead, and 16·6 oz. silver, and 2375 tons of lead concentrate, averaging 59·9% lead, 13·8% zinc, and 45·9 oz. silver, were produced. The plant for treating slime by differential flotation, as recently modified, commenced operations in March, and, during the period covered by the report, treated 20,804 tons, for a yield of 3960 tons of lead concentrate, averaging 47·9% lead, 22% zinc, and 45·2 oz. silver, and 6140 tons of zinc concentrate, averaging 39·6% zinc, 16·1% lead, and 18·5 oz. silver. The grade of these slime concentrates is stated by the directors to be fairly good; since the end of the year covered by the report the separation of the lead and zinc has been improved. At the smelting works at Cockle Creek, 83,277 tons of material was smelted, some of it being the company's concentrate, the remainder being purchased ore and fluxes, the figures for each item not being given. The yield of lead bullion was 25,319 tons, containing 39,873 oz. gold, and 1,921,370 oz. silver, but as the nature of the purchased ore is not stated, these figures are not expressive. The ore reserve is estimated at 2,211,600 tons above the 1300-ft. level. Bores below this level have proved the continuity of the orebody sufficiently to warrant the sinking of the shaft and the opening of a level at 1400 ft. The accounts show an income of £1,012,604 from the sale of products, including the metals from purchased ores, and a profit of £165,227, out of which £96,250 has been paid on the preference and ordinary shares, the dividend being at the rate of 10% in both cases. Since the outbreak of the war the mine has been worked at half time, but the smelting works at Cockle Creek have been working at full capacity, treating the output of other Broken Hill mines.

Tanalyk Corporation.—This company was formed in 1912 for the purpose of purchasing the whole of the shares of the South Urals & Smelting Co., a Russian organization owning copper deposits near those of the Kyshtim Corporation, under the auspices of which the company was floated. Particulars relating to the company and the properties were given in our issue of October 1913. The report of the directors now issued covers the year 1913, and is confined to a statement of the position of the shares and debentures. Attached thereto is a report by R. Gilman Brown, the consulting engineer, detailing the progress at the mines as at September 30 of this year. At the Mambet mine, the developments have not been up to expectations. On the 165-ft. level in the new shaft, the length of the orebody has been proved to be 500 ft. On the 232-ft. level the development so far done extends for 237 ft., and the average width of the lode is 3 ft. assaying 1·9% copper, 5·9 dwt. gold, and 5·1 oz. silver. A year ago the lode was reported to be 10 ft. wide on the 165-ft. level, assaying 2 to 3% copper, 8 dwt. gold, and 10 oz. silver. A level has been opened at 340 ft., and a cross-cut started, but it has not yet cut the lode. The results obtained by mining have not confirmed the expectations based on the bore-holes; it is evident therefore that the orebodies vary greatly in content, and that dependable information relating to them can only be obtained by underground development. The ore reserve is estimated at 71,000 tons, averaging 2·5% copper, 6·6 dwt. gold, and 6·5 oz. silver. At the Tanalyk mine, the 270-ft. level is being developed; the assay-value over 140 ft., averaging 2·5 ft. wide, was 3·7% copper, 4·3 dwt. gold, and 3·3 oz. silver. At the Semeonovsky mine, 90,000 tons of oxidized ore averaging 12 dwt. gold has been proved, and the probability is that eventually from 150,000 to 200,000 tons will be available. A cyanide plant is being erected to treat this ore. Six bore-holes were sunk below this oxidized zone, but only in one case was sulphide ore found. The first reverberatory furnace was put into commission in April, and two small converters in July.

Cape Copper.—This company was formed in 1863 to work the Ookiep copper mine in Namaqualand on the west side of the Cape province, South Africa. High-grade ore, together with matte produced on the spot, used to be shipped to the company's smelting works at Britonferry, South Wales; but recently everything has been smelted to matte locally. Of late years the output of the Ookiep mine has been small, but fairly large quantities of ore of lower grade are mined at Nababeep, and two years ago the smelter was moved to the latter mine. For some years the ore from the Tilt Cove mine in Newfoundland used to be smelted by the company at Britonferry, on a profit-sharing basis; that mine was however closed a year ago. During the past year, the option on the Rakha Hills mine in Chota Nagpur, India, was exercised, and 60,000 new shares of £2 each were issued in order to provide capital for developing it, and also for the purpose of reorganizing the smelting works at Britonferry and Nababeep. The report for the year ended August 31 shows that the reorganization at the Britonferry and Nababeep smelting plants has interfered with the output of copper, and the profit was much lower than usual, being only £17,244. The balance brought forward from the previous year, £60,757, has enabled the directors to pay £52,500 on the ordinary shares, being at the rate of 8¾%, and £11,025 on the preference shares, being at the rate of 12¼%, thus practically maintaining the rates of distribution prevailing during the last six years. At the Ookiep mine 9781 tons averaging 13·88% copper was raised. The reserve is estimated at 6000 tons of 20% ore, and developments point to a continuance of such supply. At surface there is 120,000 tons averaging 4%. At the Nababeep South 48,049 tons averaging 4·37% was raised, and the reserve stands at 160,000 tons. Smaller amounts were raised at Nababeep North and Narrap. At the Rakha Hills mine the necessary plant is in course of erection. No. 1 shaft has been sunk to 877 ft. and No. 4 to 353 ft., and the developments continue to be satisfactory.

Cam & Motor.—This company belongs to the London & Rhodesian Mining & Land group, which is controlled by J. & S. Weil. It was formed in 1910 to acquire gold mines at Gatooma, in the Hartley district of Rhodesia. The development has been centred on the Motor section. Recently a half share in the Cam and Good Shepherd properties was sold to the Giant company, belonging to the same group, for £50,000. The ore contains arsenic and antimony and is difficult to treat. A description of the metallurgical plant appeared in our issue of August 1913. The report for the year ended June 30 shows that the plant was started in February, and during the five months

treated 46,580 tons for a yield of gold worth £68,672. The manager, John McDermott, does not mention the percentage of recovery, but the directors state that during the succeeding months, July to November, the percentage has risen from 63·6 to 73. Several modifications are being introduced into the cyanide treatment with a view to increasing the efficiency of extraction, notably the washing of the roasted ore before the addition of cyanide, and the rapid treatment of the sand. The working cost was £61,447. Out of the working profit, £964 was paid as London expenses, and £2353 as interest on loans from the parent company, while £3957 was allowed for depreciation. The ore reserve down to the 6th level is estimated at 867,032 tons averaging 44s. 4d. per ton. During the year only 1211 ft. of development was done, and in no case can it be said that the reserve was increased. Since June 30, however, the reports have been more favourable, for in both the 5th and 6th levels ore of satisfactory grade has been found.

Van Ryn Gold Mines Estate.—This company was formed in 1892 to acquire property on the outcrop in the far east Rand, and it was in fact the pioneer of mining in that part of the Witwatersrand. The assay-value of the ore has throughout been lower than that of the ore in the outcrop mines in the central part of the Rand, and in addition the ground is much faulted. It was not before 1904 that the prosperity of the company was established. The General Mining & Finance (Albu group) is in charge of the management of the property, but is not in full financial control. The report for the year ended June 30 last shows that the labour troubles of July 1913 and January 1914 had the effect of reducing the output of ore by 50,000 tons and the grade by 1s. 2d. per ton. The ore treated was 439,990 tons and the yield 139,246 oz. worth £590,128, being 26s. 10d. per ton. The working cost was £351,142 or 15s. 11d. per ton, leaving a working profit of £238,986 or 10s. 11d. per ton. Out of the profit, £225,000 was distributed as dividend, being at the rate of 45%, as compared with 47½% the year before. E. G. St. John, the manager, estimates the reserve at 1,973,000 tons averaging 27s. 7d. per ton, figures practically identical with those of last year. In order to increase the available water-supply, hitherto dependent entirely on rainfall, bores have been sunk, with the result that 150,000 gallons per day additional has been provided.

Ferreira Deep.—This company belongs to the Rand Mines group, and was formed in 1894 to acquire property on the dip of the Ferreira mine in the central part of the Rand. Production commenced at the conclusion of the war and the first dividend was paid in 1904. Three years ago the small remaining portion of the Ferreira outcrop mine was acquired for 70,000 shares. The report for the year ended September 30 shows that the yield per ton has decreased by 4s. 6d. per ton, and the working cost by 2s. 7d. The tonnage milled rose by 21,000 tons, chiefly owing to the sorting not being so close, and the working profit fell by £44,000. The reason for the decrease in grade was the mining of more Main Reef and South Reef, from which still more will be drawn in future. The ore mined was 751,103 tons, and after the rejection of 11% waste, 668,530 tons was sent to the mill. In addition over 100,000 tons of waste was broken in order to provide packing for supporting the hanging wall, the mine being a notoriously dangerous one. The yield of gold was 293,870 oz. worth £1,236,631, or 37s. per ton, and the working cost was £585,930, or 17s. 6d. per ton, leaving a working profit of £650,701 or 19s. 6d. per ton. Out of the profit, £490,000 was paid to the shareholders, the dividend being at the rate of 50%. The ore in the Ferreira outcrop mine is now practically exhausted. Of the claim-area of the Deep mine two-thirds has been exhausted, and in two years the remaining area will have been fully developed. The proved reserve is estimated at 1,893,000 tons, averaging 35s. 8d. per ton, of which 548,900 tons is in pillars or in isolated positions. Owing to the exhaustion of the outcrop mine and to the lower grade of the reserve, the profit will be less in future. Percy Cazalet, the consulting engineer, gives interesting details of the methods for minimizing the dangerous nature of the hanging wall. He mentions that pillars left in the drifts are likely to burst, that is, to be the victims of the wrongly named air-blast. These pillars are therefore being removed, and timber or wall-packing substituted, which do not collapse so suddenly.

Luipaard's Vlei Estate.—This company was formed in 1888 by the Consolidated Gold Fields to acquire a property at Krugersdorp in the far west Rand. Milling was not started until 1898, and not resumed after the war until 1906. In 1909 the adjoining Windsor mine was absorbed. The control passed in 1912 to L. Ehrlich & Co., who appointed C. B. Saner manager. The property consists of four sections, two on the Main Reef series, and two on the Battery Reef to the south. Most of the ore comes at present from the two former. The report for the year ended June 30 shows that 279,120 tons of ore was raised, and after the rejection of 25% waste, 204,980 tons was sent to the mill. The yield of gold was 51,852 oz. worth £217,760, being an extraction of 5 dwt. or 21s. 3d. per ton. The working cost was £190,068, or 18s. 6d. per ton. Including the revenue from the sale of land, etc., a profit of £32,249 was made, out of which £12,205 was written off for depreciation of plant. The debenture debt has been reduced by £8445, and now stands at £87,555. No dividend is distributed on the shares, which amount to £472,012. Mr. Saner reports that 10,987 ft. of development was done, and that the reserve stands at 660,365 milling tons, averaging 5½ dwt. per ton. During the year development was re-commenced on the Battery Reef east section, and two prospecting shafts were sunk from the surface on the outcrop, one being in ore averaging 11·7 dwt. over 33 in. for 75 ft., and the other in ore averaging 5 dwt. over 55 in. for 35 ft. The old shaft and other workings have been unwatered, and sampling has given good results. The lode is wide, being at one place 150 ft. in width, but the profitable portion is 3 ft. wide and care has to be exercised in following it.

Naraguta (Nigeria) Tin Mines.—This company was formed at the beginning of 1910 to acquire alluvial tin ground at Naraguta, Northern Nigeria. Other properties have since been acquired at Karama in the Ninkada district, and at Sho near Zungeru. Frank N. Best is chairman, C. G. Lush is consulting engineer, and F. O'D. Bourke is manager. The report for the year ended March 31 last shows that 694 tons of tin concentrate was won at Naraguta, 88½ tons at Sho, and 104½ tons at Karama, total 887 tons, as compared with 519 tons the year before. The yardage sluiced and calabashed is not given, but the areas worked at Naraguta and Sho are returned at 19·37 acres and 8·84 acres. At Karama the tin was recovered from river beds and no estimate of area could be given. At the Sho and Karama properties, the testing of ground ahead of the working faces has given promising results, but sampling at Naraguta has fallen behind on account of illness among the European staff and unexpected underflows of water. The income of the company was reduced by the fall in the price of

tin, the average amount received for the concentrate being £116 per ton, as compared with £147 the year before. The profit was £20,106, out of which £8750 has been paid as dividend, £7803 written off mine-development, and £1644 placed to capital expenditure account in connection with the new pipe-line. This pipe-line is completed, and when it is brought into full operation should substantially reduce the cost.

Pahang Consolidated.—This company was originally formed in 1887 as the Pahang Corporation, having for its object the development of land and tin deposits in the state of Pahang, on the eastern side of the Malay Peninsula. In 1906 the properties of the Pahang-Kabang and Malayan Exploration companies were absorbed. In 1909 additional capital was subscribed in order to extend the scale of development, since which date excellent profits have been made. During the past year, £45,500 new preference shares were issued in order to provide the necessary pumping and hoisting plant at Willink's mine. The report for the year ended July 31 shows that the developments at Willink's continue to be highly gratifying. As recorded a year ago the orebody at this property was found, on the 500 and 600-ft. levels, to be much richer in cassiterite than the upper parts of the mine. Sinking operations are now proceeding with the object of opening a level at 700 ft., and the ore in the winzes so far sunk below the 600-ft. level are in ore of high-grade. The breaking of the crank-shaft of the Diesel engine last February caused half of the stamps to be idle for three months and the output for the year suffered accordingly. The ore milled was 137,055 long tons, and the yield 2015 tons of tin concentrate. Owing to the greater richness of the ore now mined the average yield was 1·47%, as compared with 1·07% during the previous year. In addition, 196 tons of concentrate was won by Chinese tributers from alluvial deposits. The income from the sale of concentrate was £216,162, and the profit £64,027. Out of this, £12,000 was written off for depreciation of plant, and £25,426 off development account, while £20,000 has been placed to reserve. The debenture interest £2023 was paid, and the balance of outstanding debentures amounting to £64,000 have been redeemed. The preference shares now totalling £100,000 received their 7% dividend, but nothing is paid on the £374,370 ordinary shares, the directors deeming it prudent to hold funds in hand owing to the low price of tin concentrate and the difficulty of effecting sales. J. T. Marriner is the manager.

Renong Tin Dredging.—This company was formed in 1908 on the recommendation of E. T. McCarthy to acquire tin-dredging ground near the west coast of southern Siam. The first dredge commenced operations in 1910, and, as the results were highly encouraging, additional capital was subscribed in 1913 in order to buy two more dredges, and to acquire further prospecting and dredging rights. The report for the year ended June 30 shows that No. 1 dredge treated 699,212 cubic yards for a yield of 292 tons of tin concentrate averaging 69·5% metal. The yield per yard was 0·93 lb., which was slightly above the previous figure, and compares with 0·75 lb. foreshadowed by Mr. McCarthy. The amount of gravel treated was only three-quarters of the capacity, owing to heavy clay overburden being encountered during the second half of the year under review. This zone of clay has since been passed, and the dredge is in free ground again. No. 2 and No. 3 dredges have been erected, and the latter is about to make returns. The conditions at No. 2 are not so favourable, as the overburden is a stiff mud which fouls the water and chokes the pumps and tables. It has been necessary therefore to install a pump for supplying clean water. The results of testing of new ground during the year have not been entirely satisfactory, so the question of providing any more dredges is postponed. Further leases and prospecting rights have been obtained. Owing to the fall in the price of tin the income has been curtailed. The smaller amount of ground treated due to the occurrence of clay overburden caused the working cost per yard to increase, but as the royalty was less, with the lower price of tin, the total cost per yard was less than the year before. The income from the sale of concentrate was £34,616, or £118 per ton, and the total cost was £23,018. The working cost per yard was 5d. as compared with 4¼d. the year before, and the total cost 7·89d. as compared with 8⅛d. The preference shareholders received £3750, being at the rate of 15 per cent. Owing to the present difficulties of the tin market, no dividend has been declared on the the ordinary shares.

Malayan Tin Dredging.—This company was formed in May 1911 to acquire tin-gravel properties near Batu Gajah, in the Kinta district of Perak, Federated Malay States. The report on the property was made by Nutter & Pearse, of Ipoh, Perak, and F. W. Payne & Co. are the designers of the dredging plant, which is on the bucket system. The first dredge started in January 1913. The report now issued covers the year ended June 30 and shows that dredge No. 1 was in operation all the year, and dredge No. 2 for two months. The amount of ground treated was 772,798 cu. yd., and the yield 236 tons of tin concentrate, being an extraction of 0·68 lb. per yard. The concentrate sold for £23,996, at an average price of £101 per ton. The net profit was £9474, which is carried forward. A third dredge has been built and is ready to begin work, and the parts for a fourth dredge have arrived at the property. During the year, 11,000 additional £1 shares were subscribed at £2. 10s. to provide capital for the new dredges, bringing the issued nominal capital to £110,000.

Aramayo Francke Mines.—This company was formed in 1906 to acquire tin, wolfram, bismuth, and silver mines in the south of Bolivia. Particulars of the mines were given in our issue of March 1911. The report for the year ended May 31 last, supplemented by the speech of the chairman at the meeting of shareholders, shows that 4218 tons of tin concentrate was sold for £352,046, as compared with 3353 tons the year before. The sales also included 58 tons of wolfram, 342 tons of copper matte, and an unspecified amount of bismuth. The increase in the sales of tin was due to accumulations of previous years caused by lack of transport having been sent to market, the actual production for the year being 3442 tons, obtained from 44,366 tons of ore. It will be seen that the yield of black tin is 8%. The net profit for the year was £135,764, out of which £59,684 was distributed as dividend, being at the rate of 10%, while £20,000 was devoted to the extinction of debentures. The fall in the price of tin began to affect the profits of the company toward the end of the year under review. With the incidence of the war, delivery to Germany, where much of the concentrates were sold became impossible, as was also the collection of debts owing for previous consignments. The cost of freight and war risks made shipments to other countries prohibitive. It was decided to stop mining work, but to continue milling and development. More recently conditions have improved and mining has been started again. A leaching plant is to be erected to treat the tin-silver ore at Chocoya, as European buyers have not offered a sufficiently remunerative price. Financially the company is in a strong position.

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Scientia non habet inimicum nisi ignorantem.

T. A. RICKARD, Editor. EDGAR RICKARD, Managing Director.

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STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
January 1914	621,902	29,851	651,753	2,768,470
February	597,545	28,716	626,261	2,660,186
March	657,708	29,093	686,801	2,917,346
April	655,607	28,270	683,877	2,904,924
May	689,259	30,970	720,229	3,059,340
June	688,232	29,694	717,926	3,049,558
July	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,588,075

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
June 30, 1913	188,094	9,060	14,654	211,808
July 31	170,242	9,403	13,378	193,023
August 31	158,223	9,236	13,172	180,631
September 30	152,637	9,361	12,321	174,319
October 31	148,882	9,377	12,712	170,971
November 30	147,569	9,286	12,680	169,535
December 31	150,012	9,516	11,811	171,339
January 31, 1914	154,202	9,471	11,979	175,652
February 28	157,673	9,508	12,266	179,447
March 31	162,815	9,619	13,390	185,824
April 30	165,005	9,625	14,150	188,780
May 31	165,433	9,619	14,284	189,336
June 30	166,248	9,442	13,256	188,946
July 31	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Cost per ton	Profit per ton	Total profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
January 1914	1,902,733	27 4	18 2	9 3	876,577
February	1,861,442	26 10	17 11	8 10	823,654
March	2,094,098	26 4	17 3	9 1	945,000
April	2,075,561	26 6	17 3	9 3	955,600
May	2,196,287	26 3	17 0	9 3	1,011,968
June	2,178,161	25 5	17 1	9 5	1,025,629
July	2,281,717	25 10	16 9	9 1	1,032,562
August	2,261,800	25 5	16 8	8 9	988,567
September	2,188,939	25 11	16 9	9 1	989,859
October	2,301,795	25 8	16 8	8 9	1,004,264
November	2,192,365	26 3	17 0	9 0	982,346

The above are the official statistics published by the Transvaal Chamber of Mines. They understate the cost by about 15% and overstate the profit by about 30%.

Gold Output of India.

Year 1912	Year 1913	Year 1914	Jan. 1915
£2,265,094	£2,299,315	£2,340,259	£201,255

Production of Gold in West Africa.

Year 1911	Year 1912	Year 1913	Dec. 1914	Year 1914
£1,069,442	£1,497,179	£1,634,700	£147,699	£1,727,044

Production of Gold in Rhodesia.

Year 1911	Year 1912	Year 1913	Dec. 1914	Year 1914
£2,647,894	£2,707,368	£2,903,267	£309,669	£3,530,207

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
January, 1914	9,762	102,261	112,023	475,840
February	8,493	94,812	103,305	438,809
March	1,173	91,446	92,619	393,418
April	8,774	90,233	99,007	420,553
May	7,138	99,068	106,206	451,132
June	1,725	99,290	101,015	429,081
July	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435,164
September	1,535	103,577	105,112	446,485
October	2,028	99,366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495

Other Australasian Gold Production.

	1912	1913	Dec. 1914	1914
	£	£	£	£
Victoria	2,039,400	1,847,400	176,400	1,740,300
Queensland	1,484,160	1,118,610	105,800	1,011,310

Since the commencement of the war the usual monthly statistics of production have not been published by the New South Wales and New Zealand governments.

American Copper Producers' Association's Figures.
In Tons of 2240 lb.

	Production.	Deliveries: Domestic	Deliveries: Foreign	Deliveries: Total	Stocks at end of month
Total 1913	724,307	342,566	387,974	730,540	—
January 1914	58,826	21,409	39,266	60,675	38,933
February	54,715	21,244	37,455	58,699	34,949
March	65,023	31,184	39,983	71,167	28,805
April	67,634	28,315	36,761	65,076	31,363
May	63,530	24,818	32,460	57,278	37,615
June	63,101	20,637	32,745	53,382	47,334

No figures published since, and Association dissolved at end of 1914.

The United States Customs report exports as follows: July 34,145 tons, August 19,676 tons, September 23,866 tons, October 28,995 tons, November 1–28, 20,170 tons, December 7 to January 9, 24,366 tons. No record is published of shipments between November 28 and December 7.

Nigerian Tin Production.
In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Dec., 1914 tons	Year 1914 tons
2,532	5,032	326	4,832

Production of Tin in Federated Malay States.
Estimated at 70% of concentrate shipped to smelters.

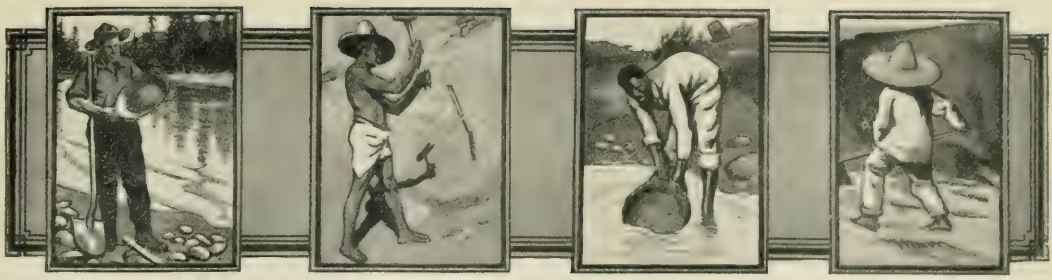
1911 tons	1912 tons	1913 tons	Dec., 1914 tons	Year 1914 tons
43,967	48,250	50,128	4,351	49,042

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151½	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January 4, 1915	328⅝	£28,353	£86 4 11
January 18	214½	£18,785	£87 13 8
February 1	215¾	£19,892	£96 13 8

Imports of Tin Concentrates at Liverpool.
Reported by H. A. Watson & Co.

	Bolivia tons	Nigeria tons	S Africa tons
December—			
Concentrate	422	421	60
Metal Content	253	295	42
January—Concentrate	4188	447	308
Metal Content	2513	313	216



REVIEW·OF·MINING

INTRODUCTORY.—Business on the Stock Exchange, being limited to cash dealings, is small. Bulls and bears, alike so contributory to speculative excitement, are debarred from participation. Hence dulness. Among the departments exhibiting activity, we may mention Far East Rand shares and Russians, but not until the advance in quotation has passed the level of the end-July make-up is a spurt possible, for up to that level the particular stock is affected by liquidation arising from the early war crisis. This explains alike the steadiness of Modder B and the recent jump in Kyshtims. Broken Hill shares have improved on hopes of an adjustment of the metal-contract difficulty. Russians are favourably affected by their domestic metal market; and they are likely to benefit further from the improved sentiment toward everything Russian arising from the military and financial alliance. Among the events of the month the most notable is the embargo placed by the Treasury on new issues of capital. This has affected several mining flotations, notably two tin issues, but it does not jeopardize the raising of any working capital necessary for going concerns. It does tend further to emphasize the paternalism incidental to a great war. Another notable event is the financial agreement between the three Allied Powers, announced on February 6, whereby the financial burdens due to the war are shared, particularly as to the loaning of money to the junior participants on our side.

TRANSVAAL.—The figures for the output of gold during January, and for the number of natives employed at the end of the month, had not arrived when we went to press. The output will have been reduced by the floods in the far west Rand, and by the fall in the yield from the Crown Mines.

Recent developments at the Brakpan and Springs mines have shown an improvement. At Brakpan 4460 feet of development was done in banket during the last quarter of the year, and of this just one half or 2240 feet was in ore, the average content being 14·7 dwt. over 39 inches. During the preceding quarter, 1960 feet out of 4750 feet, or 41·2 per cent, was in ore having an average of 12·78 dwt. over 43·2 inches. The results at Springs were even better, for 73 per cent of the developed banket was ore averaging 34·5 dwt. over 34 inches. From the beginning of operations the proportion of banket proved profitable has been 54 per cent, averaging 22·7 dwt. over 26·7 inches.

The figures for the results at the Crown Mines during December disclosed the disconcerting fact that the yield per ton was only 24s. 5d. A year ago the average content of the reserve was estimated at 28s. 5d. per ton, and allowing for 5 per cent loss in extraction, the average yield per ton should be 27 shillings. Thus the December figure is 2s. 7d. below the calculated normal. The ore milled was 183,000 tons, the gold extracted £223,460, and the profit £74,070. The profit was only 60 per cent of the average forecasted on the formation of the company in 1909. The directors announce that the grade of ore treat-

ed during January continued below the normal and that the cause of the discrepancy is being carefully investigated.

The board of the Central Mining & Finance Corporation is to be reconstituted. The first change is the retirement of Messrs. F. Eckstein and L. Reyersbach, and the appointment temporarily of Sir Lionel Phillips as chairman.

The mill of the Modder Deep was started on December 14 and for the rest of the month was run on trial. Since January 1 the operation of the plant has been continuous. During January 25,750 tons averaging 9 dwt. was sent to the stamps. As only a portion of this tonnage passed through the cyanide plant, no figures for yield are published.

Luipaard's Vlei, in the far west Rand, is suffering from floods following the heavy rain. The engines are occupied in baling, and milling is suspended with the probability of the stamps being idle for at least a fortnight.

The main shaft at the Bantjes collapsed in December owing to the flooding of the mine following heavy rain, and the repairs have been hindered by subsequent renewals of adverse weather. The output is limited at present to 2000 tons per week, as compared with the normal 5500 tons. It is not probable that the repairs will be completed before the end of February.

The Wolhuter has had a good year and will apparently provide no further anxious moments. It is one of the the few outcrop mines of the central Rand that have failed to provide bonanzas. The ore is not of high grade and the country is much broken. Two years ago special efforts were made to increase the ore reserves so as to secure greater regularity in the output. During the past year the reserve was increased by 215,000 tons to 999,400 tons averaging 5·9 dwt. Judging by claim-area the company should have a further life of seven years.

The Lancaster West company is to be liquidated. The mine is in the far west Rand and belongs to the Goerz group. Small dividends were paid in 1898 and 1903, but the company is still in debt to debenture-holders. Mining and milling were suspended in 1913.

The Union Steel Company of South Africa has required more capital for the building of its works at Vereeniging than was contemplated three years ago on the initiation of the scheme. Debentures to the extent of £100,000 have been issued and also £41,974 8% cumulative participating preference shares. More plant is now in course of erection, and it is hoped before long to have the capacity of the works at the level originally intended, 10,000 tons per year. The steel products are all made from scrap, and the manufacture of pig iron from the deposits at Magnet Heights, near Lydenburg, is still a long way off.

The Transvaal Gold Mining Estates, which owns mines at Pilgrim's Rest, has ordered 5 new stamps for the Elandsdrift property, and a tube-mill for Vaalhoek together with additional cyanide and slime plant. At the present time operations are seriously hampered by excessive rainfall. The Graskop mine is not accessible, power-supply is interrupted, and transport is most difficult. The mines of the Glynn's Lydenburg company, in the same district, are also suffering from the floods.

Owing to the public revenue of the Union falling short by two million pounds, the Government is intending to increase the taxation on the profits of the gold mines. The extra income to be obtained is estimated at £500,000. The present 'profits tax' yields about £1,200,000. The controllers of the mining industry of the Rand cheerfully assent to the proposal.

RHODESIA.—The yield of gold during December was worth £309,669, figures not differing greatly from those of the previous month. Eldorado Banket was £7000 lower at £11,229, extracted from 4096 tons of ore, but the figures for November were abnormally high. Lonely Reef was £2500 higher,

though £3500 less than in July and August. The Shamva mill reached its full capacity of 50,000 tons per month, and the yield was £2000 up, but the extraction per ton was only 11s. 7d., the lowest figure yet, and comparing with 15s. 2d. in July. The total yield of gold in Rhodesia during 1914 was £3,530,207, as against £2,903,267 in the previous year.

The development at the Globe & Phœnix at depth below the dike continues to give improving results. The reserve on December 31 was calculated at 194,400 tons averaging 29·5 dwt. per ton, as compared with 188,000 tons averaging 29·1 dwt. on September 30 and 180,757 tons averaging 27·2 dwt. in December a year ago. The figures are not as good as they were three years ago, when 178,582 tons in reserve was estimated to average 36·6 dwt. per ton.

At the Lonely Reef mine the inclined shaft, which was started from the 9th level to follow the ore-shoot, has been sunk to the 13th level, from which a cross-cut was driven to the lode. At the point of intersection, the lode was proved to average 2 ounces over 30 inches. Driving on the 12th level has been done from the bottom of a winze sunk from the 11th level, and for the distance so far driven, 120 feet, the assay-values are 18 dwt. over 40 to 52 inches.

As indicated in this column last month, the directors of Tanganyika Concessions have had to ask the debenture-holders to consent to a postponement of the payment of interest, owing to the war upsetting the finances of the Union Minière du Haut Katanga. At the meeting of debenture-holders it was announced that the production of copper during 1914 was 10,600 tons. Two more furnaces are to be erected immediately, bringing the total to five, of which an average of four will be running, one being held in reserve. When these are at work the monthly output will be 2000 tons of copper.

The copper produced at Katanga, formerly shipped to Germany, is now coming to England. The steamer *York Castle* brought 2000 tons to Swansea early in January for delivery to the rolling-mills.

WEST AFRICA.—The output of gold for December was £147,699, the lowest figure since July. Abbontiakoon yielded £2300 less, though treating more ore; the cause of the fall is stated to be the absorption of gold in the tube-mill linings. The return from Ashanti Goldfields was £35,982 from 18,080 tons or 59s. 7d. per ton, the yield per ton declining to the figure foretold by Mr. W. R. Feldtmann, the consulting engineer, in his last yearly report. The yield per ton at Broomassie fell from 73s. 4d. in October to 40s. 6d. in December. Prestea produced £1000 more than in November, the figures being £39,978 from 26,478 tons. The yield at Cinnamon Bippo increased £800 to £5443.

The Broomassie report for the year ended September 30 shows a serious fall in profits. The tonnage and yield per ton were maintained, but trouble with plant and machinery caused additional expense, and owing to the development giving consistently disappointing results it was necessary to write-off larger sums from the development-redemption account. On the West Reef the reserve was estimated on the date mentioned at 11,644 tons, equal to a four months' supply. At the present time the mill is treating ore from the East Reef, and the reserve is estimated at 120,000 tons. Nothing is said of the assay-value of this ore, but it is stated that it is proving to be richer than was indicated during development. Mr. A. M. Mackilligin, a member of the board, is on the spot, directing prospecting operations.

The extension of the Bauchi light railway to Bukeru was opened on December 10. A through train from Zaria to Bukeru is now run in connection with the main-line boat-train.

The report of the manager, Mr. A. R. Canning, on the properties of the Northern Ni-

geria (Bauchi) Tin company discloses a gloomy state of affairs. He practically advises a restart with systematic boring and sampling, a department of the work hitherto neglected. Calabashing has been done in the richer parts during the last two years and an output of 25 tons per month maintained. Mr. Canning proposes to cut this down to about 18 tons, pending the completion of the two treatment plants, one a jet-elevator and the other an oil-driven gravel-pump.

AUSTRALASIA. — Our Melbourne correspondent comments on the circular issued by the North Broken Hill company detailing the present position as affected by the war.

The blast-furnaces of the Broken Hill Proprietary at Newcastle are to be started in March and the rail-mills in May. The company has received preliminary orders for steel rails from the New South Wales and South Australian governments, the amounts being 2500 tons and 2000 respectively.

The adverse effect of the war on the Broken Hill community is reflected by the fact that the departures during the months August to November exceeded the arrivals by 5889. We may expect an increasing exodus.

An inspection has been made by Mr. O. B. Ward, on behalf of the Broken Hill Block 10 company, of gold mines on islands off New Guinea. The Kulumadau mine on Woodlark island has been worked by a Charters Towers syndicate for some years. On Misima island the gold is found on a wide lode and the ore can be broken by quarrying and cyanided direct, the prospective recovery being about 3 dwt. per ton. The company has taken an option on the Misima property.

Some misunderstanding has arisen concerning the geological investigation of the Kalgurli mine as made by Dr. Malcolm Maclaren. The diamond-drilling below the 1850-ft. level was undertaken on his advice to prove finally that there was no ore below that level and not in the hope of disclosing additional supplies of ore, as has been inferred. The manager of the mine, Mr. Robert Black, has always been perfectly frank in regard to the non-persistence of the orebodies.

At the South Kalgurli Consolidated, diamond-drilling below the 1800-foot level, undertaken with a view of finding a lode believed to pass into the company's ground from the Kalgurli mine, has been successful, and the lode has been intersected by several holes. The gold content at these points is variable. The lode is in the favourable country-rock of the district, quartz-dolerite. Development by ordinary methods is to be started.

The sulphide plant at the Victorious mine at Ora Banda, belonging to the Associated Northern Blocks, has been started. The arsenic content is becoming a serious anxiety, and stoping at certain points has been suspended pending metallurgical investigation.

The oxidized ore at the Yuanmi was exhausted at the end of January. The sulphide plant is treating 2000 tons per month.

On the reduction of the scale of operations at the Mount Bischoff tin mine, some of the men were employed in prospecting on an outlying property recently acquired. They have discovered an alluvial deposit that promises to yield large amounts of coarse cassiterite.

The Lake Margaret hydro-electric installation, belonging to the Mount Lyell Company, has been completed and current is being supplied to the mine and works.

The developments in depth at the Talisman are not encouraging at present. The drifts north and south on the 15th level from the bottom of No. 12 winze are in barren lode. In No. 6 winze below the 14th level, the lode is 5 feet wide and averages over 2 ounces per ton.

INDIA.—In future the monthly outputs of the Indian gold mines are to be reported in fine ounces instead of bullion. Two years ago the alteration was made from long to short tons in the declaration of ore treated.

In the deepest level of the North Anantapur, the 750-ft, the lode is reported to be 3 feet wide and to assay $2\frac{3}{4}$ ounces per ton. During the installation of the tube-mill and the re-organization of the cyanide plant, ore richer than the average was treated in order to maintain profits, so that the January output was abnormally high at 1990 fine ounces. The recent discovery of a new lode at depth in the Balaghat is proving to be distinctly promising, for in a winze below the 3330-foot level the width is 18 inches and the assay-value 2 ounces 8 dwt. The development in Bullen's section at the Ooregum continues to be good; on the 50th level the lode is from 5 to 6 feet wide and assays from 27 to 34 dwt. The Mysore announces the discovery of a new ore-shoot on the 7th level south of the auxiliary shaft in Ribblesdale's section. The shoot as at present disclosed is 1 foot wide and assays 12 dwt. per ton, but the management has reasons for watching developments with hope. In the 14th level from the auxiliary shaft, Ribblesdale's shoot is 4 feet wide and assays 24 dwt. per ton.

CANADA.—The policy of the directors of the Dome Mines at Porcupine in milling large bodies of low-grade ore apparently does not please investors. But the last monthly return, for December, shows that 23,030 tons of ore yielded gold worth $81,660, or $3·83 per ton, and it must be remembered that, in March last, the consulting engineer, Mr. W. W. Mein, indicated that the average yield on the large scale of working then inaugurated would be $3·80, so that technologically everything is perfectly correct. The Hollinger, being in ore that can be mined selectively, is giving good results to shareholders, the latest monthly report showing that 19,673 tons of ore was treated, averaging $13·22 per ton, at a working cost of $4·50 per ton. Before long, the number of stamps will be increased to 80, and another 20 are being installed at the Acme property. The monthly dividend has been recently increased from 3 to 4 per cent. The Tough-Oakes mill is to be in operation at the end of March, with a capacity of 150 tons per day.

Cobalt is handicapped by a serious shortage of electric power, due to low water in the rivers. The Northern Ontario Light & Power Co., operating three plants on the Montreal and Matabitchouan rivers, with a normal capacity of 17,000 h.p., has now only an output of 10,200 h.p. The mills of Cobalt alone require 5000 h.p. To meet the emergency, an arrangement has been made by which every mill is to close-down for one week out of every four. This went into effect on January 25. Some of the companies preferred to close for three weeks at a time, so as only to have one stoppage, others closing in rotation each for one week in every month. About 300 men have been thrown out of employment. Many of the mines have auxiliary steam-plants, which will enable them to continue underground work. The Porcupine district is not affected.

The Canadian Government has appointed a Commission to investigate the nickel position, not so much with a view to tracing the ultimate destination of Canadian nickel refined in New York as with the object of ascertaining whether the metal can be refined within the Dominion.

News comes from the Mayo district, on the Upper Stewart river, Yukon Territory, of rich finds of silver-lead ore. Massive argentiferous galena is reported, also pyrargyrite. A thousand tons has been hauled to Mayo Landing on the Yukon river for shipment to smelters at the end of the frost. Prospectors are rushing to the district from Dawson.

UNITED STATES.—The American Copper Producers' Association has been dissolved. At the outbreak of the war, the Association ceased to publish the monthly figures for the deliveries of copper from the American refineries for home consumption and export, so that the dissolution

of the Association was not unexpected. The suppression of these monthly statistics does not help the public to understand the American copper position.

The output of copper from mines in the United States during 1914 is estimated at 507,000 long tons, as compared with 547,000 tons during 1913. The production of zinc is given at 322,000 tons, as compared with 318,000 tons.

Gold has been shipped from China to the United States, the reason being that, owing to the dislocation of finance caused by the war, settlements for Chinese purchases in the United States are not effected entirely in London as heretofore, and direct dealings have been inaugurated.

The Alaska Gastineau company reports that the first ore was hauled through the Sheep Creek adit on December 24 and delivered to the coarse-crushing plant. The electric-traction plant up Sheep Creek has been completed, superseding the more expensive haul from Juneau. The metallurgical plant is ready, and the commencement of milling is only awaiting the completion of certain conveyors and electric details.

MEXICO.—The past month has been full of incidents, military and political, without bringing affairs measurably nearer a definite conclusion. The Carranza forces, under General Alvaro Obregon, defeated the Zapatistas and re-occupied the city of Mexico on January 29, having been forced to evacuate the city last November. Gonzalez Garza, who succeeded Eulalie Gutierrez as provisional President, resigned forthwith. A report that General Francisco Villa had been killed was denied vigorously by that forceful person himself. Meanwhile Villa's troops are trying to capture Tampico, and Carranza occupies Vera Cruz. The prohibition, by Carranza, against the export of oil from Tuxpam and Tampico was withdrawn upon protest being made by the Mexican Eagle Oil Company to the British and American governments. Obregon has cancelled the paper money issued by Villa, and the latter has proclaimed himself "in charge of the Presidency." And so the sordid tragedy of Mexican misrule proceeds through another chapter.

Lateral development at the Santa Gertrudis has resulted in the cutting of a new lode on the 16th level at a distance of 700 feet south of the North lode. In the cross-cut the lode was 10 feet wide and assayed 19 oz. silver and 1 dwt. gold per ton. Driving was started on the lode, and cable messages reported that for the first 48 feet the assay-values averaged 57 oz. silver and 4 dwt. gold. Subsequent cables indicate that the length of the shoot so far proved is 185 feet, with a width of about 10 feet, and that the average assay-value is 35 ounces silver and 4 dwt. gold.

RUSSIA.—The engineers of the Irtysh Corporation will be leaving shortly for Siberia, and as soon as the weather conditions permit will make the necessary alterations in the 50-ton experimental concentration plant, so that regular production may be inaugurated. The site of the smelter at Ekibastus is being prepared, and zinc smelting will probably commence early in 1916.

In the early days of the war, the Kyshtim production was affected by the loss of men due to mobilization. The number of employees has since been restored to normal, and regular production during 1915 may be expected, at the rate of 8000 tons per year. At the Tanalyk, the smelter is producing blister copper, which is sent to Kyshtim for refining. The Tanalyk cyanide plant is to start in the spring.

The Caucasus copper mine is reported to have suffered little or no damage at the hands of the invading Turks, and a few employees have been allowed to return. It is interesting to record that the steam-shovel plant was started shortly before the war, and had given excellent results, in spite of interruption of

transport facilities and the necessity to use manual labour instead of locomotives for moving the cars.

The Lena Goldfields, though owning a controlling interest in the Russian company, the Lenskoie, has been forced by circumstances to leave the technical direction of the mining and washing operations to the Siberian engineers. The valley of the Bodaibo and the adjoining creeks have yielded gold worth £40,000,000, and since the commencement of mining in 1863 the average extraction per yard has varied from 60 shillings downward. At the present time the average yield is perilously near the cost, at 29 shillings per yard. It is a matter of common knowledge that the local methods of drifting are expensive and that serious losses occur in washing. Moreover, there are extensive tracts of gravel of lower grade that cannot be attacked by drifting. Mr. C. W. Purington, an engineer conversant with Alaskan methods, was appointed last year by the London company to confer with the Russian engineers, and to induce them to modify their practice so as to meet the altered circumstances. Mr. Purington, after a lengthy study of the deposits, has made recommendations, which may be conveniently divided under two heads. One set has for their object the reduction of cost and increase in recovery under the present system, and the others relate to the policy desirable for exploiting the lower-grade deposits. The former can be adopted at small cost and the necessary changes will be made gradually. But it is obviously impossible to give consideration to the latter at present, for they involve the expenditure of large sums of new capital. Of all the suggested improvements, the least costly will be the placing of quicksilver in the riffles, a practice used everywhere, even on dredges. Mr. Purington estimates the reserves that can be treated at a profit by present methods at over 4,000,000 yards, which will take 4½ years to treat.

A new railway is to be built from Petrosavodsk to Sorotsk bay, thus connecting Petrograd direct with the White sea. At the present time the connection between Archangel, on the White sea, and the Russian railway system is over a single track of narrow-gauge line, and naturally the transport facilities are restricted. The new line will be of importance politically and commercially.

VARIOUS.—The Exploration Company is doubly the victim of circumstances, and feels the effects of both the European war and the Mexican strife. Its subsidiaries, the El Oro, Buena Tierra, and Santa Rosa, have had to suspend operations periodically, but fortunately no material damage has been suffered at the hands of the various aspirants to Mexican domination. Development has been continued all the time, with satisfactory results, at the three properties. The company's holdings in copper securities are promising, especially those in Chile Copper and Inspiration.

At the Bawdwin mine of the Burma Corporation the internal shaft is 233 feet down, still in ore of high grade. The Tiger tunnel, or adit, has been driven for 926 feet. For the remainder of the distance, about 5000 feet, work will be done by Water-Leyner drills which, with an air-compressor, have just been supplied. The rate of progress will be greatly accelerated thereby, for hitherto the drilling has been done by hand.

The reserve shares of the Deebook Dredging company are on option to Lionel Robinson, Clark & Co. The company is a Melbourne venture and owns 440 acres of tin-bearing ground in Western Siam. The first dredge commenced work on August 9 last, and a second dredge has been ordered.

The war has had a serious effect on the china-clay industry in Cornwall and Devon, for deliveries to the continent are practically suspended. During December the total export from this country was 15,870 tons as compared with 58,406 tons during December 1913.

EDITORIAL

AN experienced mining engineer for whom we have profound respect states in a report that during the past year 2715 tons from the " waste heaps " was sent to the mill along with the ore from the mine. He could have avoided a controversy as to the correct use of terms by calling them 'dumps' instead.

BY the death of Charles Martin Hall, American metallurgy suffers a distinct loss. His rival in the development of the process of extracting aluminium, Paul Heroult, died a year ago. Both of them were young in years, but old in experience, and, after being opponents, they settled their differences in the reasonable way.

WE publish an article by Mr. Morton Webber on errors latent in the sampling of mines. This engineer has made several useful contributions to the general subject of mine-valuation. On the present occasion he deals with erratic assays and with those most difficult cases in which ordinary sampling fails to give the information required. We shall be glad to receive comment from other members of the profession.

THE INSTITUTE of Marine Engineers is the latest technical society to build a house for itself. Appropriately to its associations, the site is on Tower Hill, in the centre of shipping interests, and easy of access from the termini of the great railways to the north. The institute was founded in 1888, and its membership is now 1500. The Institution of Naval Architects attends to the construction of the ship, and the Institute of Marine Engineers to its propulsion and steering. The British Empire provides ample scope for both.

A DAILY contemporary announced recently that Sir Thomas Dewar would give a lecture at the Royal Institution on liquid air. The Fleet Street editor who changed 'Sir James' to 'Sir Thomas' evidently knew more about liquid fire.

SOME of our friends twit us for our endeavours to impress upon our readers the necessity for precision of expression and clarity of style. They allege that such things are mere frill and frou-frou. One quotes Robert Burns, who said that "rank is but the guinea stamp, the man's the gold for all that." Our rejoinder is that gold impressed with the guinea stamp is a much more useful article for the purpose of purchase and exchange than the gold in its raw and unrefined state.

THE COPPER deposits at Tsumeb in German South-West Africa were originally developed by an English syndicate, the Damaraland Mining and Exploration Company, which was formed to acquire a concession granted to Mr. Robert Lewis by Kamcherero, the Chief of the Damaras. Sir Donald Currie was a supporter of the enterprise, and the technical work of proving the orebodies was done by Mr. Christopher James, of Swansea. After the territory had been ceded to Germany, the concessions were purchased by Berlin capitalists, and large amounts

of money were provided by the German government and the banks for the building of the necessary port and railway, and for prospecting, development, and erection of plant. Until the outbreak of the war the rich copper ore and the copper-lead matte were shipped to the Perth Amboy works of the American Smelting and Refining Company, near New York. The silver-lead bullion was sent to Germany.

SLIDES on the Panama Canal continue to cause anxiety, but rumours recently circulated have been unnecessarily alarming, and were probably due to a misinterpretation of the official notice to the effect that deep-draught warships would not be able to pass through on their way to the Panama-Pacific Exposition. As a matter of fact, ships drawing 25 feet have passed through the Canal during the last few days, and inquiries show that shipowners have not cancelled sailings. As we have already recorded, the igneous rock of Recent age, through which the Culebra cut passes, is in process of decomposition and is unstable to a degree hitherto unknown to civil engineers. This Recent rock constitutes a flow over older granite, which stands firm. Probably slides will continue until the decomposed rock is entirely removed and the stable rock-surface exposed. With time and patience these natural difficulties will be overcome.

LEAD PENCILS used in this country are made mainly by German and Austrian firms, either at their home factories or at branches established here. The remainder comes from the United States. The most famous deposit of high-grade graphite was that at Borrowdale, Cumberland; for a long period these Keswick pencils supplied the English demand and were popular abroad; but the deposit was exhausted half a century ago, after having provided a handsome income to successive owners for three hundred years. The chief sources of graphite at the present time are Bohemia, Bavaria, and Ceylon, with smaller amounts coming from India, Italy, Spain, the United States, and elsewhere. The manufacture of lead pencils is, however, a comparatively unimportant factor in the graphite market, for it represents only 5% of the world's output. Stove-polish consumes 30% and crucibles and refractories 35%. Graphite is also used in the manufacture of protective paints and lubricating compositions. The artificial variety is made by separation of the carbon from molten cast-iron, and by the Acheson process in the electric furnace.

THE late William Edgar Allen was one of the great personalities in Sheffield. Not only was he noted, as a business man, for his keenness to adopt every possible means for the improvement of commodity and method, but he had an unusually wide knowledge of European languages, which was of immense service to him in founding and maintaining a market for his manufactures on the Continent. He also had two works in the United States, where his special steels are in demand. He was a man of culture and wide reading, and devoted much of his wealth to providing his fellow townsmen with facilities for study and research. The library at the University of Sheffield was one of his benefactions, and he endowed a lectureship in geography for the benefit of the same institution.

THE COURT of Appeal, consisting of seven members, has issued a judgment defining the positions in our courts of the enemy alien and of the English company controlled by the enemy alien. As regards the individual alien, it was held unanimously that he could not sue, but could be sued. The result is that he cannot collect debts in this country. The standing of the enemy alien incorporated under the Company Acts was pronounced, by a majority of the court, to be

upon a different footing, and it was held that registration at Somerset House brought a German mercantile organization under the protection of British law. Lord Justice Buckley was the sole dissentient, holding that incorporation merely created an artificial legal entity, and that the shareholders and directors were the actual people. The six judges no doubt correctly interpreted the law as it exists today, but the dissentient judge's opinion should admonish the Government to abolish or modify the legal fiction.

THE DELAY in issuing yearly reports constitutes a real grievance to shareholders, and, as a rule, it reflects adversely on the business ability or candour of the directorate, though, of course, distances and lack of communications account legitimately for some delay. An admirable example of promptness is provided by the Tongkah Harbour Tin Dredging Company. The scene of the operations is an island off the coast of the Western Siamese States, and the head office is at Hobart, Tasmania. Nevertheless, the report for the year ended September 30 last was in our hands on January 20. The report is in excellent style, full of vital information and figures, carefully tabulated and analysed, and presented in such a way as to give the reader the minimum of trouble. To some of our boards of directors in the City of London we would say: Go and do likewise.

WE HAVE always admired the vitality of the Chemical Metallurgical and Mining Society of South Africa. Year in and year out, throughout all the seasons, the monthly meetings have been held, at all of them excellent practical papers being read, followed by sincere and strenuous discussion. Now comes the news that a reduction is to be made in the number of meetings during the year from twelve to eight, by the omission of the usual meetings in June and July, and December and January. No other technical society has been able to hold meetings every month without a break, so the new move of the South African society merely brings it into line with those in other countries. The society admits that the difficulty of securing suitable papers has increased recently, and the attendance at the meetings has latterly been small. No doubt the labour troubles and the war have provided the mine managers and technologists with matters of more pressing importance, but the actual reason probably lies in the fact that metallurgical practice on the Rand has become established on well defined lines, with little opportunity for discussion or improvement. The problems for the future lie in the domain of mining practice and mechanical science, and come within the scope of the South African Institution of Engineers. At the meetings of this Institution we have recently had important papers on ventilation, rock-drills, pumping, and power-plant, and the discussions have been distinctly helpful. We have no doubt that in the near future South African engineers will desire some sort of rapprochement between these two societies; in fact it only requires the word of some man of influence to effect the amalgamation.

THE ULTIMATE destination of mineral products is not, as a rule, matter of common knowledge. What proportion of Chile nitrate is used as fertilizer and how much goes to the makers of nitric acid and explosives? Nickel is used for warlike purposes in the manufacture of armour-plate and bullets, and, in the more peaceful arts, for nickel-plating, and for the production of nickel-brass, once called German silver, which forms the basis of table goods, whether silver-plated or otherwise. Who can tell us the amount going to these various applications? Professor Alfred Stansfield, of the McGill University, Montreal, whom we quoted last month,

states that two-thirds of the nickel production of the world is used in the manufacture of nickel steel. On the other hand, an official of the International Nickel Company, of New York, which controls a large part of the Canadian output of nickel, says that fully one-half is bought by the makers of household nickel-brass. He also says that it is obviously bad policy on the part of nickel producers to sell their metal to the manufacturers of ammunition, because the nickel coating of a bullet costs only one farthing, while the man that is killed by the bullet might have bought a pound's worth of nickel in the form of forks and spoons if he had lived. But of course every bullet does not kill a man; thousands are fired for every fatal wound inflicted.

The Charter of the Institution.

On January 15 the announcement was made officially that "the King has been graciously pleased to approve the grant of a Royal Charter of Incorporation to the Institution of Mining and Metallurgy, whose objects are defined as for the advancement of the Science and Practice of Mining in respect of minerals other than coal and of Metallurgy in respect of metals other than iron." On the same day it was announced that a similar charter had been granted to the Institution of Mining Engineers, an organization formed in 1889 by the federation of a number of mining institutes, chiefly in the Midlands, the North of England, and Scotland, and devoted to the subjects expressly omitted from the claims of the sister organization, namely, coal and iron.

Our readers are aware that the steps taken by both of the mining societies to obtain a charter were opposed by the Institution of Civil Engineers, which, in order to prevent a trespass on its supposed preserves, presented a protest, in the course of which sundry claims and allegations were submitted. Most of these claims are falsified by its own records, and some of the allegations may be accepted as verbal inexactitudes of a regrettable character. In the charter of the Civil Institution, no mention of mining is made, although numerous branches of engineering are specified. Yet mining as an art antedates, not only the foundation of the Civil Institution, in 1818, but most of the branches of engineering to which it is expressly devoted. Only recently a special committee of the Civil Institution issued a bulletin on the education of engineers, and in that bulletin the education of mining engineers is ignored, although various and sundry other branches are carefully tabulated. In its statement, the Civil Institution claimed that "during the last five years 390 original articles and abstracts of foreign publications referring to mining and metallurgical subjects" had been published in its transactions. This assertion is grossly misleading, for only 7 original papers are comprised among the 390, the remainder being mere abstracts, many of which had only a remote bearing on mining and metallurgical engineering. And concerning the 7 original papers it can be said that alike by their character and place of publication they failed to be of noteworthy value to the art of mining. One more claim commands our attention, namely, that the roster of the Civil Institution includes 94 engineers on the roll of our Institution. As an argument against the grant of a charter to the latter, this claim is beside the mark, of course; for many members of both institutions are also members of other scientific societies. However, we shall not dwell long on this phase of the quarrel, for we conclude that the time has come for those 94 gentlemen to resign from the Civil Institution and align themselves, for good and all, with the organization that so worthily represents their own profession. We are glad to be able to state that an excellent example has been set by the President, Dr. F. H. Hatch, who has tendered his resignation to the secretary of the Institution of Civil Engineers.

The grant of the charter of incorporation, coming soon after the acquirement of a freehold home in the City, marks the coming of age of the Institution and the recognition of mining engineering as an independent profession. The Civil Engineers have had the effrontery to regard the mining engineer as a sort of disreputable relation from the backwoods, and to arrogate to themselves a position of patronage over a branch of engineering to which the British Empire owes a large part of its world-wide expansion. The time has come for the mining profession to assert itself, its identity and its independence, with no uncertain voice. Let the bridge and dam builders, civil or uncivil, go their way and let us make up our minds to go our way. Much remains to be done, for the production of the metals, other than iron, is essential to that complex scheme of living called civilization. In order that it may be well done, the profession of mining engineering must have a recognized social status, neither subordinate to any society that chooses to ignore one of the basic occupations of mankind, nor pliant to the activities of flamboyant finance, but independent, honourable, and energetic, ready to play its proper part in the continued development of the mineral resources of the Empire.

Nigeria and Whitehall.

At the meeting of the Naraguta company, held in December, the chairman, Mr. F. N. Best, made public sundry grievances against the Colonial administration in Northern Nigeria. In our October issue we referred to the hardships imposed by the closing of the mining area to further prospecting pending a re-survey that is being spread over two or three years. These incidents have impelled us to make a general inquiry into the relations subsisting between those operating the mines and the authorities administering the affairs of the colony. We shall record the result of that inquiry, which is prompted by an understanding of mining as a pioneer of industry and a keen sympathy with the shareholders who have supplied the capital for an important advance in mineral development. We hold no brief for the lucky speculators that have used the tin boom in Nigeria as a means of perpetrating financial adventures, in which a mineral discovery is only the counter in a gambling game; nor do we feel called upon to attack these gentlemen as against an official class that is pleased to look upon the basic industry of mining as a risky pursuit of a somewhat reprehensible character. To us mineral exploration is the pioneer of civilization; mining is a basic industry; and the business incidental thereto is as legitimate and fundamental as that of agriculture.

One of the first grievances arises from the granting of Exclusive Prospecting Licenses or *permis de recherche* over large areas for a period of one year, renewable for three, during which the licensee is supposed to select the ground he desires to exploit under a Mining Lease. When the end of the three-year tenure approached, in 1913, the Government left unsettled the question of a further extension of time, so that the plans of the mining companies were in the air. Finally, early in 1914, a fourth year was granted, with a charge of £12½ per square mile, as against the £5 levied previously. In this matter we think the mining companies, in many cases, were wrong. Three years should have been time enough for a selection of the ground to be located for a lease. Some companies obtained rights over areas exceeding 100 square miles; there was no valid reason why so large a tract should be alienated for a longer period than the three years allotted. On the other hand, several companies obtained these prospecting rights over areas designed to cover water-rights, without which their operations would be futile. The Government seems to have lumped the good and the bad cases, so as to work injustice in several instances.

Excessive royalties and rents have been, and are, being charged. In part this is due to the fact that the Government has to share the proceeds with the Niger Company, the original concessionnaire that opened up this part of West Africa to the white man's enterprise. When the British Empire bought-out the Niger Company, the latter received £1,000,000 in cash, with half of the royalty and rents to be collected. This explains why the Chamber of Mines, which is dominated by the Niger Company, is ineffective as an exponent of the mining industry. The freight on machinery and supplies, even on a reduced basis, is £6 per ton of 'tin' produced, the royalty was £6. 10s., and the freight on the 'tin' £12 more, making £24. 10s., paid to the Government. Another £25 remains in the country, as native wages, rents, import duties, transport of white staff, &c., so that £50 per ton is spent in Nigeria. The Mines Inspector, Mr. Langslow Cock, states that the average cost of producing tin from Nigeria is £100 per ton of 'tin,' namely, a concentrate containing 70% metal, so that, to meet expenses, the market for the metal must be at £143 per ton. This average of £100 is probably high, unless it includes foolish ventures and needlessly poor management. On September 3, 1914, the Government granted reductions in railway rates and in royalty, temporarily. But the operators were left on tenterhooks, for no assurance was given as to time. At the end of the year, the period was extended to March 31, 1915, with a statement that the old rates would be restored thereafter. Having conceded the argument that the rates were excessive, the Government reimposes them. The Governor, Sir Frederick Lugard, made reference to the fact that during the last 15 years tin has been much lower than even today, "and indeed has rarely been so high." This, of course, is an argument against continuing rates that were fixed at a time when the price of tin, according to his own acknowledgment, was abnormally high.

Next, we come to two incidents that illustrate the vacillation and irresolution that have done so much to create a loss of confidence in the colonial administration of Nigeria. The first relates to the application for a lease at Karama. The grant of it was delayed by insistence on an official re-survey, although the ground had been surveyed and re-surveyed by a competent member of the mining company's staff. This part of the country was closed pending the general re-survey of the so-called minefield, and by the time the permission to work was finally accorded, the delay had rendered it impossible to take economic advantage of the wet season.

The second case is even worse: In August the Lieutenant Governor telegraphed to the Chamber of Mines stating that the legal penalties for suspension of operations would not be enforced, on account of war conditions, yet when a formal request to be allowed to suspend operations is sent, at the request of the Acting Inspector, the reply comes, at the end of November, that His Excellency the Governor "is not prepared to allow the suspension of operations on Mining Leases and Exclusive Prospecting Licenses." Meanwhile, acting on the first notification, the white staffs of several companies had been sent home. In the same telegram the collection of rents also had been waived, but on that point also the Governor had seen fit to dishonour his deputy. Such an episode is unique, of course, but it serves to indicate the paralysing vacillation of the administration. As for plain stupidity, we may instance the regulation whereby boundary beacons had to be built of cement posts 3 feet thick; later, the size was reduced to 1 foot, but the use of cement, at £25 per ton, in the jungle of West Africa, is an example of ineptitude that is truly pathetic. Moreover, the boundary lines had to be hoed, in a region where undergrowth, of course, grows rankly in every wet season. We cite

these cases to prove that the administration of an important mining region should be done under competent technical advice and that good reason exists for irritation on the part of the mine operators.

The inconsiderate treatment of which the Nigerian mining companies complain is due to deep-seated causes. Among numbers of our people, well informed in most matters, there is a curious lack of knowledge concerning mining affairs both in their industrial and political bearings. In London particularly the industrial phase of mining is hidden by the glitter of speculation, causing the average man, especially of the official class, to look upon mining as a queer business connected with questionable performances on the Stock Exchange. Hence the colonial administration, hearing of the spectacular winnings of sundry promoters and financial adventurers, is apt to regard mining as a shady performance worthy less of protection than of productive taxation. To them mining is mainly commendable as a source of revenue. This may seem an over-statement, to which any official is entitled to demur, but we are convinced that the idea prevails to such a degree as largely to explain the official attitude toward mining operators. We share the idea ourselves to the extent of considering many Stock Exchange dealings as a blemish on a great industry; ideally it would be nice to conduct the operations of mining without the gambling in shares; but it has been ascertained by experience that the speculation in scrip affords a ready way of raising capital for the real work at the mines. Nobody suggests that diplomacy should be discarded on account of the prevarications incidental to that polite profession, nor does anybody despise farming because grain speculators use its products as a counter in their games. The vagaries of promotion and share-dealing are incidental, not fundamental, to mining, which still remains one of the two basic occupations of humanity.

In rapping the Nigerian promoters on their knuckles, the Colonial Office is doing a grave injustice to thousands of shareholders that have invested their money with the legitimate idea of exploiting the tin deposits, not the pockets of their fellow citizens. What is more, the Colonial Office is doing a grave injustice to the mining industry, to the industry that has opened the West Coast of Africa to British enterprise and to British civilization. Our people do not realize sufficiently that the miner, and after him the mining company, is the pioneer not only of industry but of Empire. Trade follows the flag, it is true, but the flag follows the pick. The ignorance of most Englishmen concerning the history of their Empire is pathetic if they fail to appreciate the great fact that our overseas dominions were won by the mining adventurer whom Whitehall regards now with averted eye. It was the search for gold, and the discovery of it, that presaged the development of Australia; it was the mineral explorer that opened up two-thirds of Canada; it was the prospector who found the diamonds and the gold, and led the way for those that painted the map of South Africa red; it was the intrepid gold-seeker that opened a way into the fever-stricken Gold Coast, conquering disease, distance, and difficulty until the jungle awakened to organized industry; not the soldier but the miner won for us the largest part of our far-flung empire; the miner blazed the trail on which Whitehall now camps contentedly. Now that the hardships have been faced and the dangers overcome, are the miner, the mining engineer, and his friend the capitalist to be considered as disreputable relatives, fit chiefly for the imposition of regulations and taxes that cripple their further work in the extended development of the mineral resources they have uncovered? We trust not. The sense of fairness is ingrained in our people, whether official or non-official. To that sense of fairness we appeal.

Gold in 1914.

The production of gold has suffered no serious interference from the War. The rebellion in South Africa did not appreciably check the yield either on the Rand or in outlying districts. The arrangement whereby the Bank of England advanced 97 per cent of the cash value of bullion deposited in the local banks enabled the mines throughout the British Empire to continue operations. Shortage of cyanide and zinc threatened at one time to cause trouble, and in some cases temporary difficulties arose. Reduction of output owing to shortage of supplies, however, has been negligible. The decreased gold production of Mexico was due to internal strife and was apparent long before the beginning of the European war. The Russian figures will doubtless exhibit a decline owing to shortage of labour, as the call to arms has extended to even the remote villages of Siberia. Probably for the same reason the French mines will have yielded less gold. As far as published figures are concerned, we are able to report increases in Rhodesia, West Africa, and the United States, and decreases in the Transvaal and Australia. From the technological point of view the decrease in the Australian output is the most serious feature of the year's results.

The output of the Rand during 1914 was 8,033,567 ounces, as compared with 8,430,998 ounces in 1913, and 8,753,563 ounces in 1912. In the outside districts the output was 344,570 ounces as compared with 363,826 ounces in 1913, and 370,731 ounces in 1912. The total output of the Transvaal was valued at £35,588,075 as compared with £37,358,040 in 1913 and £38,757,560 in 1912. Generally speaking, the mines in the west Rand are giving poorer results, and many of the mines in the central Rand are stationary or beginning to decline, while on the other hand, the conditions and prospects in the far east Rand are excellent. As we have observed on previous occasions, the Rand as a whole has passed its zenith. Rhodesia presents substantially higher figures than hitherto recorded, the output being worth £3,530,207 as compared with £2,903,267 in 1913 and £2,707,368 in 1912, the chief cause of the increase being the accession of the Cam & Motor and the Shamva to the list of producers. In West Africa the output was worth £1,727,044 as compared with £1,634,700 in 1913 and £1,497,179 in 1912.

The yield of gold in Australia continues on the down-grade. In Victoria the production for 1914 is reported at £1,740,300, as compared with £1,847,400 in 1913 and £2,039,400 in 1912. Bendigo and Ballarat are back numbers, and the only hopeful spot is in the Ararat district where the deep leads of Langi Logan may put new life into Victorian mining. The figures for Queensland are £1,011,300, as compared with £1,118,611 in 1913, and £1,484,160 in 1912. The fall is due chiefly to the exhaustion of the Charters Towers deposits. The output of West Australia was valued at £5,237,308, as compared with £5,582,140 in 1913, £5,449,057 in 1912, £5,823,522 in 1911, and £6,682,042 in 1910. The figures for New South Wales, South Australia, and Tasmania have not yet been published officially, but we may estimate them at £490,000, £25,000, and £85,000 respectively, all three cases indicating a diminishing output. The failure of the Great Cobar accounts for part of the fall in New South Wales. Though the Cobar is known chiefly as a copper mine, gold was produced from the 10-dwt. silicious flux obtained from the Cobar gold mine, which was purchased a few years ago. The closing of the Tasmania gold mine at Beaconsfield accounts for most of the decrease in Tasmania. As far as can be judged by present information, the yield of gold throughout the Commonwealth during 1914 was worth £8,590,000, as compared with £9,347,000 in 1913, and £10,865,000 in 1912. The New Zealand figures are not published as yet, but they may be estimated

at £1,500,000, slightly higher than those for 1912 and 1913, but much less than during the palmy days of the Waihi.

The Indian figures for 1914 show a slight and continuous increase, the production being worth £2,340,259, as compared with £2,299,315 in 1913 and £2,265,095 in 1912. The vitality of the Mysore group is one of the most gratifying features of present operations in gold mining, and the indications are distinctly favourable to a continuance of profitable mining in depth. The chief centres of gold production in Canada are Porcupine in Ontario, British Columbia, and the Yukon. The provisional figures for Ontario are £1,110,000, for British Columbia £1,160,000, and the Yukon £1,120,000. These totals are much the same as those for 1913 and 1912 in the case of British Columbia and the Yukon, but showing an increase for Ontario of £200,000 over 1913 and £1,000,000 over 1912.

The official estimate for the yield of gold in the United States during 1914 is £19,000,000, an increase of £700,000 over 1913, but almost exactly the same as in 1912. The figures for Alaska are slightly higher, at £3,250,000 as compared with £3,120,000 during 1913, but they are £250,000 lower than in 1912. The Philippine Islands yielded £217,700, an increase of £72,500. California and Colorado showed small increases, and Nevada and Utah slight falls. With the exception of the Philippines, the variations for the year presented no feature of note. Of other foreign countries the production during 1914 can only be roughly estimated. The figures for the East Indies, British and Dutch, may be taken at £1,000,000, those for Japan and Korea £1,750,000, China £750,000, Mexico £3,750,000, Central America £750,000, Russia £5,500,000, Europe £500,000. Of other parts of Africa not yet enumerated, Madagascar, Egypt, and the Ivory Coast are the chief producers and their figures may be taken at £400,000. As regards South America, we have little exact information, but there is no reason to believe that the output of gold will vary greatly from that of the two preceding years, which has been estimated at about £3,000,000, though as the mines are distributed over millions of miles in Brazil, Colombia, Peru, Guiana, and other states, it is obvious that the estimates are not absolutely exact.

The total production throughout the world during 1914 was approximately £93,000,000 as compared with £95,000,000 in 1913, and £97,000,000 in 1912. We have not space on the present occasion to compare the present production with that of the years anterior to 1912, but in a succeeding issue we intend to recapitulate some of the earlier history of gold production.

The Pato Again.

Since our last issue went to press, we have received a copy of Mr. W. A. Prichard's report on this gold-dredging enterprise in Colombia, and we have read it with keen interest. The report is satisfactory, not only as a lucid presentation of the technical features of the undertaking, but as explaining the discrepancy between the actual yield of the gravel and the estimates formulated by Messrs. C. H. Munro and A. P. Rogers. In the light of Mr. Prichard's more recent examination it is apparent that the earlier estimates of Messrs. Munro and Rogers were correct. The discrepancy is due entirely to the digging of the richer portion of the alluvial area, not to any error on the part of the engineers. This is a fact we are glad to place on record, for we hold that an under-estimate is as much an engineering blunder as an over-estimate. The business of the engineer is to ascertain the facts and to state them explicitly. Mr. Prichard indicates, in no captious spirit, that the earlier examinations were made under conditions less favourable than his own. Mr. Rogers drilled 16 holes and sank 4 shafts; Mr. Munro drilled 82 holes; Mr. Prichard

drilled 89 holes, and used the results from 38 drilled by Mr. Munro, 6 drilled by Mr. Rogers, and one by Mr. E. B. Kimball. The number of bores was insufficient for a close estimate, says Mr. Prichard; and we agree with him, for in the area already dredged the average was one per ten acres. It appears that the difficulties of washing due to the presence of clay in the gravel were not fully weighed, but it is also clear that those difficulties have been exaggerated in actual dredging by reason of inadequate clear water. Moreover, in the early drilling of the Pato property "a theoretical factor arrived at in an entirely different field was necessarily used." We understand that the factor of safety as applied to the drill-hole pannings was 20%, the figure generally used in the Oroville district of California. Now it appears that despite the use of a foreign factor, insufficient drill-holes, and inadequate allowance for the difficulty created by bands of clay, despite also the relatively brief time available for Mr. Munro's examination, his estimate of 31 cents for the 310 acres is amply confirmed by Mr. Prichard after the latter has spent one year on the ground and checked his results in the most painstaking manner. He makes the average 31·6 cents for the larger area of 528 acres, and we may well omit the decimals as suggesting an accuracy that is unattainable in work of this kind. Since the dredge has been at work in the prospected area, it has obtained a yield just double that of the prospectus report. Instead of 31 cents the gross return has averaged 62 cents per cubic yard. But the discrepancy is due to the fact that the dredge, for convenience in operation and to meet the exigencies of company finance, has been steered into a strip of ground known to be much richer than the average. This has been admitted frankly, and it is reflected in the share quotation, which evidently does not anticipate a long continuance of the present rate of yield. According to Mr. Prichard, this super-grade gravel is so limited as not to affect the general average to an appreciable degree. On the whole, therefore, the information now available is gratifying in so far as it corroborates the technical acumen of the three engineers concerned. There is no discrepancy between them, nor with the facts ascertainable. Mr. Prichard says that "considering the circumstances under which they were made, and in the light of recent and more exhaustive examination, I consider that the early prospecting reports on the property are very creditable." We move to delete the two qualifying sentences.

Tin and the War.

Tin occupies an entirely different position with regard to the war from that of the other base metals: copper, lead, and zinc. Two-thirds of the world's production comes from the British Empire or its dependencies, these in order of importance being the Malay peninsula, Cornwall, Australia, Nigeria, and South Africa. Moreover, the smelting and marketing of the tin produced in these countries are under British control. Outside the Empire, Bolivia is the most important source of tin, the smelting of this output being nearly evenly divided between England and Germany. The Dutch islands, Banka and Billiton, off the coast of the Malay peninsula, and China are the only other regions contributing in any substantial manner to the tin resources of the world. The United States is a negligible factor in the production, though it is the largest individual consumer of the metal. Germany, in the last decade, can only be credited with a few hundred tons production per annum, and depends upon the additional metal obtained by smelting Bolivian concentrate and by purchases in the open market. Tin is not a necessity in the manufacture of war material. Tin and antimony may be added to the lead contained in bullets and a limited amount of bronze is used. On the other hand tin-plate plays

an important part in the storage and transport of food and other materials. Neither tin nor tin-plate has been placed on the list of contraband for the reason that no neutral country supplied either of them to Germany before the war. Exporters of tin from British possessions to neutral countries guarantee under bond that the metal shall not ultimately find its way to Germany, and the exports of tin-plates from South Wales are prohibited to neutral countries adjacent to Germany, such as Holland, Sweden, and Denmark. We have heard rumours, but only rumours, of intended shipments of tin-plate from the United States to Denmark. The supply of tin concentrate to Germany from Bolivia has ceased, of course, and for a time the presence of German warships in the South Pacific made it inadvisable for producers to despatch consignments even to England. The shipments of metal from the Malay peninsula were likewise checked by the presence of the *Emden*; in fact, one ship, the *Troilus*, carrying 900 tons, was sunk by that enterprising corsair. The sales of Banka and Billiton tin were for a short time suspended by the Dutch government. The outbreak of the war had the effect of bringing the market for tin to a standstill. Buyers, knowing that this metal would not be required for munitions, anticipated a general depression of trade, so that the market became practically non-existent. It was not so much that the price was depressed as that there was no price at all. As a matter of fact the price had been tumbling, in a threatening manner, for several months before hostilities commenced, owing largely to adverse circumstances in America, and producers and users had already become accustomed to the altered conditions before the paralysis caused by the war supervened. At the present time, tin-plate manufacturers are trading warily, while the mines have been anxious as to the marketing of their outputs and the prices to be obtained.

With regard to markets and output, it is of interest to note that the predominating firm of distributors is A. Strauss & Co., of London, which owns the Penpol smelter near Falmouth and has more recently erected a modern plant near Liverpool. Mr. Arthur Strauss, though of German origin, has been identified with English interests and was at one time Member of Parliament for the Camborne division of Cornwall. Another great power in the tin world is the Straits Trading Company, whose smelter on the island of Pulo Brani opposite Singapore is by far the largest in existence. It is commonly said in the East that this company indirectly controls the destinies of the Malayan tin industry. The third great personality of the tin mining industry is Señor S. J. Patino, a picturesque figure of humble origin, who controls nearly one half of the Bolivian production. The Dutch government has a smelter at Banka, where the output of its mines is treated, and the metal is sold by auctions in Holland and in Java. The Queensland output is mostly smelted at Irvinebank, the New South Wales concentrate goes to Pyrmont near Sydney, while the Tasmanian production is treated at the Mount Bischoff smelter at Launceston, though some of the Australian output finds its way to Singapore. The South African concentrate goes chiefly to England, and a small proportion to Singapore, while the Nigerian output comes entirely to England. We have already said that the Bolivian concentrate goes partly to England and partly to Germany. A small proportion of the output is smelted at the mines, but the scarcity of local fuel and the high cost of imported coke is against the production of metal on the spot. Of English smelters Williams, Harvey & Co., which is nowadays identified with the good old metallurgical name of Pearce, has the largest business, their headquarters being at Bootle, near Liverpool, having been transferred from Hayle a few years ago. We also have

the Consolidated Tin Smelting Co., at Redruth, once owned by Mr. Alfred Lanyon and now controlled by Vivian, Younger, & Bond, and the Redruth Smelting Co., owned by the Bain family. Though the United States is so great a consumer, no smelting of imported ore has ever been done there. Fifteen years ago an attempt to establish a smelting industry was made, under the ægis of the Government, which arranged for the imposition of a protective import-duty on the metal. The hope was that the Malay concentrate would be shipped to New York for treatment. However, the Straits Trading Company exercised its influence among the rulers of the Malay States, and succeeded in effecting a strategical move whereby an even greater prohibitive export-duty was levied on concentrate sent abroad for treatment. At the present time some of the American publicists are advocating the foundation of a tin-smelting industry, and the opening of the Panama Canal and the failure of the German market for Bolivian concentrate coincidently make such a proposal attractive.

The normal yearly output of tin throughout the world is in round figures 125,000 tons, as compared with 100,000 tons ten years ago. The increase is distributed among all the producing countries with the exception of Australia. The greatest increase is shown by Bolivia, a country that promises still further expansion. The output of the Malay peninsula, commonly called 'Straits' tin, is about 63,000 tons per year, of Bolivia 20,000 tons, the Dutch East Indies 17,000 tons, Cornwall 5000 tons, Australia 5000 tons, South Africa 2600 tons, and Nigeria 4500 tons. The only figures available for China are those of export, which averages 6000 tons, but large quantities must also be used locally. Smaller amounts are produced in Germany, France, northwestern Spain, Portugal, Mexico, and Alaska. As regards the future, Nigeria is the only region besides Bolivia that promises an increase of output. It is too early to give figures for the output for 1914, but judging by the periodical reports issued during the year, the figure will be about 110,000 tons.

Tin was one of the earliest of metals known to man, though for a long time it was not fully differentiated from lead, being considered merely a variety of that metal. Probably the fact that the two metals form an alloy necessary in joining pieces of either, or both, led to this view of their nature. From prehistoric times down to the 12th century the Cornish streams and alluvial deposits supplied practically the whole output, though Portugal and northwestern Spain were also producers. In the Middle Ages the tin in the mineral lodes of Saxony and Bohemia attracted the attention of the miners, and in the succeeding years the Saxon stamp-mill was introduced into Cornwall and an attack commenced on the lodes in the 'old county.' The production of Cornwall was at its maximum, at 12,000 tons per year, forty years ago. It is probable that tin was discovered independently in China, and that from there its use spead to Japan. The provinces Yunnan and Kwang Si in Southern China are still large producers. The Chinese operators penetrated into Siam and came down through Perak to the extreme south of the Malay peninsula, and at the present time the greater proportion of the work in Malaya is in Chinese hands, though during the last thirty years English capitalists have taken a financial interest in the country. Tin was first worked on a commercial scale in New South Wales and Queensland about the year 1872, and in Tasmania in about the same year. Some tin is also produced at Greenbushes in Western Australia. Bolivian ore first came to Europe in 1883.

In early days tin was used in the manufacture of alloys, forming bronze with copper, and pewter and solder with lead, and as a protective coating for copper. The problem of making tin adhere to iron and steel was beset

with difficulties that took a long time to solve on a practical scale. Though the process was known in Bohemia in the 17th century, it was not until the South Wales steel-makers solved the problem that tin-plate became a regular commodity. At first, of course, it was intended for use in the manufacture of domestic and similar utensils, but with the coming of steam transport and the rapid development of new countries, the hermetically-sealed package containing animal or vegetable food came into vogue and tin-plate manufacture received a tremendous impetus. Twenty years ago the expansion of the American canning trade induced the ironmasters of the United States to establish tin-plate factories, instead of importing plates from Wales. Germany is also a maker of tin-plate, but imports from Wales more than she makes. England has a large export business in plates, exporting twice as much as the home consumption. The yearly production in Wales is about 750,000 tons, and of this 500,000 tons is exported. At the present time about 15 per cent of the output of tin is used in tin-plate manufacture. We have already mentioned the employment of tin in the making of bronze, and of pewter, solder, Britannia metal, and other white-metal alloys. About 70 per cent of the world's output of tin is devoted to the manufacture of alloys. There is a prevalent but erroneous supposition that the greater part of the output goes to tin-plate manufacture. The facts that specially pure tin is required in tin-plate manufacture, and that the market price for tin is based on this quality, are no doubt the cause of this misapprehension. The compounds, such as tin oxide and stannate of soda, also account for some notable part of the consumption, the oxide being used in the preparation of enamels and the stannate of soda by calico-printers. The tetrachloride of tin is a valuable mordant in the dyeing of silk goods, but much of this is prepared from what the Americans call secondary tin, that is, from discarded articles of manufacture such as old tin-cans. Putty powder, an artificial oxide of tin, is employed for polishing glass, granite, and marble; tin amalgam is used in the manufacture of mirrors; and tin-foil is used for packing small articles.

The nature and distribution of tin ores and the theory of their origin provide the geologist and mining engineer with many fascinating problems. The number of tin minerals is small compared with those of other metals, and practically only the oxide is of any wide occurrence. Cassiterite when found in the original matrix is usually in or near palæozoic granite, associated with wolframite and the sulphides and sulph-arsenides of iron and copper; other sulphides such as those of lead, zinc, and silver often being present as well. The weathering of the granite and the adjacent rocks has removed the sulphur, arsenic, iron, copper, etc., and the untouched cassiterite has accumulated in river-beds, alluviums, and boulder-clays. The grains can be collected by various forms of the vanning shovel and batea, and by the riffle and other simple contrivances. The recent introduction of the bucket-dredge has opened-up large areas of tin-alluvial that would be otherwise unprofitable. Thus the operations of mining and dressing in alluvial regions such as Malaya, China, Australia, Nigeria, and Swaziland are based solely on mechanical considerations. On the other hand, the successful dressing of lode-tin and the smelting of the concentrate are full of complications, and the treatment of the ores of Cornwall and Bolivia requires the highest metallurgical skill. Of all the so-called base metals, tin is surrounded by the brightest halo of romance. Its mode of lode-occurrence provides the geologist with the attractive but unsatisfying theory of pneumatolysis, while the economic humourist points with glee to the re-appearance of the coating of the old tin-can as an integral part of the princess's gown.

PERSONAL.

F. K. BORROW has obtained a commission in the Royal Garrison Artillery.

STANLEY C. BULLOCK expects to leave Collahuasi, Chile, at the end of February.

H. M. A. COOKE has been appointed superintendent of the Ooregum gold mine, India.

A. SPENCER CRAGOE has returned to London from Spain.

T. LAUNCELOT DAWSON has been taken prisoner by the Turks in Anatolia.

FREDERICK P. DEWEY is Acting Director of the United States Mint.

FRANCIS DRAKE is here from Rhodesia.

GEORGE HOWARD FERGUSON has been appointed Provincial Minister of Lands, Forests and Mines for Ontario.

J. A. FORTESQUIEU has returned from India.

ARTHUR GIFFORD has resigned the position of superintendent of the Mysore gold mine, and is succeeded by R. H. P. BULLEN, hitherto superintendent of the Ooregum mine.

T. J. GREENWAY has been appointed president of the Technical School, Melbourne.

J. A. LEO HENDERSON sailed for New York on January 23 by the *Franconia*.

J. W. HUTCHINSON has succeeded ALBERT BURCH as manager of the Goldfields Consolidated mine, Nevada.

W. R. INGALLS has been elected president of the Mining and Metallurgical Society of America.

ROSWELL H. JOHNSON and L. G. HUNTLEY have opened an office at 306 State Hall, Pittsburgh, the firm being known as Johnson & Huntley.

T. J. JONES is returning to Russia.

J. T. KEATING has gone to the Argentine.

EDWARD KELLER is in charge of the sampling and chemical departments of the Raritan copper works.

FREDERICK LAIST has been appointed metallurgical manager for the Anaconda Copper Mining Company, and will be in charge of both the Anaconda and Great Falls plants.

ANDREW C. LAWSON has been appointed dean of the School of Mining in the University of California.

ERNEST LEVY is here from Rossland, British Columbia.

BRIAN LLEWELLYN, son of Arthur Llewellyn, has obtained a commission with the Royal Engineers.

A. N. MACKAY sailed on January 28 for the Republic of Colombia.

P. S. MORSE has resigned as manager of the Cockle Creek smelting works of the Sulphide Corporation and is succeeded by F. H. EVANS.

PETER N. NISSEN is lieutenant in the Nottinghamshire and Derbyshire Regiment, usually known as the Sherwood Foresters.

T. M. OWEN, lately of Broken Hill, is in charge of the flotation plant treating the zinc ore from the Elm Orlu mine, in Montana.

CYRIL E. PARSONS has returned to Rhodesia.

ARTHUR L. PEARSE sailed for New York on the *Franconia* on January 23.

H. A. PIPER has returned to South Africa.

BERNARD PRICE has been elected president of the South African Institute of Electrical Engineers.

W. A. PRICHARD is returning to Colombia, going first to California.

G. B. REYNOLDS has gone to Venezuela.

T. A. RICKARD returned from New York on the *Lusitania*.

J. H. RIDER, who was consulting mechanical and electrical engineer for the Rand Mines Ld. for five years, has joined the London firm of consulting engineers, Preece, Cardew, & Snell.

GEORGE SAFFORD is with the Army Service Corps at Reading.

H. ROSS SKINNER, manager of the East Rand Proprietary, has arrived from Johannesburg.

H. R. SLEEMAN has left for Western Australia.

C. A. SMITH, mine manager for the Caucasus Copper Co., passed through London on his return to the United States.

E. W. SPENCER has been appointed manager of the Abosso mine, West Africa.

W. G. SWART has joined the staff of the Hardinge Conical Mill Co. as consulting engineer in the Western States.

F. W. THOMAS has gone to Nicaragua to take the management of the Babilonia properties.

S. C. THOMSON, for some years consulting engineer to S. Neumann & Co., is now in New York with an office at 14 Wall Street.

SAM TRAYLOR, of New York, has been in London.

J. C. VIVIAN has left for Spain.

CHARLES E. WATSON has been appointed manager of the four mines at Cobalt belonging to the Canadian Mining Corporation.

H. E. WEST has joined Charles Butters' engineering staff at Oakland, California.

R. B. YOUNG has returned to South Africa.

THE ROLL OF HONOUR.

Supplementing Lists in previous issues.

AARONS, J. B.
Commonwealth Military Force.

ADAMSON, C.
Royal Fusiliers.

AINSLIE, E. M.
Royal Garrison Artillery.

ANTHONY, C. V.
Royal Garrison Artillery.

BALCOMBE, C. P. L.
Royal Engineers.

BARNETT, L. W.
Royal Field Artillery.

BECKHUSON, D. F.
West Riding Regiment.

BERGHEIM, P.
Royal Garrison Artillery.

BORROW, F. K.
Royal Garrison Artillery.

CALVERT, L.
Duke of Cornwall's Light Infantry.

CHAMBERS, A. E.
1st King Edward's Horse.

COBELDICK, W. M.
London Electrical Engineers.

CROSLEY, H. C.
Royal Electrical Engineers.

DARE, NORMAN F.
Royal Field Artillery.

D'ARTOIS, C.
London Electrical Engineers.

EVERETT, R. C.
2nd King Edward's Horse.

FENNELL, J. H.
Royal Field Artillery.

FIGGIS, W. E.
2nd King Edward's Horse.

FORD, W. S.
East Surrey Regiment.

GOODWIN, J. A.
Royal Engineers.

GOW, K.
Royal Fusiliers.

GWYNNE, R. H. B.
Royal Garrison Artillery.

HARPER, NORMAN
New Zealand Expeditionary Force.

HARRIS, J. L.
West Lancashire Divisional Engineers.

HARRISON, G. A.
5th Battalion South Wales Borderers.

HEYWOOD, L. R.
Royal Engineers.

HILL, LIONEL E.
East Yorkshire Regiment.

HOPLEY, C. F. C.
Sportsman's Battalion.

HOSKINS, N.
London Scottish

HOWARD, ALLEN C.
West Riding Divisional Royal Engineers.

JOHNSON, C. F.
Imperial Light Horse.

JONES, S. RAMPLEN
Unattached.

KELSALL, J. L.
Army Service Corps.

KERR, H. R.
Norfolk Regiment.

MCWILLIAM, K. J.
Imperial Light Horse.

MUNBY, E. J.
Royal Engineers.
(Killed in action in France on Jan. 31).

NEWBERY, J. W.
2nd King Edward's Horse.

NEWSOME, J.
Life Guards.

NISSEN, PETER N.
Sherwood Foresters.

POPE, W. A.
Army Service Corps.

PRICE, T.
Royal Field Artillery.

ROSS, H. R.
Royal Fusiliers.

SAWYER, E. G.
1st Cavalry Brigade.

SCOTT, E. B. R.
Royal Engineers.

SOLOMON, J. B.
County of London (Artists' Rifles).

STEWART, G. C.
Royal Fusiliers.

STICKLAND, R. S.
Royal Field Artillery.

STIDOLPH, N. H.
2nd Rhodesian Regiment.

TAYLOR, G. N. T.
5th Battalion, East Lancashires.

THOMAS, H. BISSELL
Royal Field Artillery.

ULRICH, GERHARDT
New Zealand Engineers, Egypt.

WARD, V. F. F.
Public Schools Battalion.

WHITE, G. B.
7th Battalion, Bedfordshires.

WOLSELEY, E. C.
Staffordshire Yeomanry.

WRIGHT, E. G. D.
South African Forces.

WYNN, C. W. M.
9th Lancers.

SPECIAL CORRESPONDENCE

MELBOURNE.

Metals and the War.—The year 1914 has come and gone. We in Australia shall look back upon it as a year when Nature and Man united to test both our manhood and loyalty. In a dreamy way we had talked of war and of the need for universal training to service in arms. We set to work, under the belief that the Japanese were at our door, to build-up an army and navy. Meanwhile we had quite forgotten that Australia had a pestilent foe in the drought. Today we are sharing in national perils on the field and on the deep. Not face to face with the Japanese, but beside him, our supposed foe being welcomed and supported. In the first rush to enlist, the call was that of the blood. The story of Belgium, and the knowledge of the colossal preparation of the German and of his deep-seated envy of the British people, have converted goodwill into racial bitterness. The sentiment of the people is amazing in its intensity. Consequently, even the drought, now it is here, is of secondary interest, except that it has crowned the distress we have had to suffer from the war. From natural causes the pastoralist and the farmer are being beggared, but it is the raging fire in Europe that has brought home to the industrial population the real meaning of a great war. All the mining districts have felt the stress. At Broken Hill only half-time is being worked. Mount Morgan has had to discharge many men. Mount Lyell struggles to keep its staff intact. Wallaroo & Moonta has had to reduce wages, and far-off Hampden, in North Queensland, finds it difficult to maintain operations and make a profit. Of course this only means that we are sharing in a world-wide trade depression, due to the cutting-out of some of our best markets for our leading primary products. All the same the experience is our first taste of the realities of war, and we hate those who are responsible for it.

Not that attempts are wanting to adjust industry and commerce. One fact that has sunk into the brain of the Australian is the way in which the German has captured the metal trade of the world. Allusion has been made before to the dominance here of the German metal-buyer. The chief houses concerned in the trade have been the Australian Metal Company, Aron Hirsch & Sohn, and the representatives of Beer, Sondheimer & Co. These have largely captured the trade in Broken Hill lead and zinc concentrates, and they have had their hands on copper and the rare minerals. The association of some of our mines necessarily was fairly intimate with some of these great houses, and the military authorities have been going through records to establish how close has been that connection. Concerns like the Mount Lyell company, the Broken Hill South company, the North Broken Hill company, and the Broken Hill Proprietary all have had to submit to examination. With the Proprietary company the search was long, apparently because of the fact that before the war the company was a member of the Lead Convention. Finally the Federal Attorney-General, W. M. Hughes, made an important statement in which, after giving all Broken Hill companies a clean bill of health, he discussed the command of Germany over the metal trade of the world. To his mind this position was inconceivable, and he disclosed the fact that the Federal Government had felt it to be a national duty to direct the attention of the British Government to the matter, especially in relation to the Australian production of minerals.

The bar to either Australia or Great Britain acting is the existence in the agreements for the sale of concentrates and metals of a clause that apparently suspends the operation of a contract until after hostilities cease. Mr. Hughes thinks that legislation will be necessary to provide an opening for British capital to take up the trade. As a free trader, he is loth to impose an export duty on concentrates, but that may come. If it should, there is not the least doubt that German capital will still try and retain its hold on the trade by some subtle action. It is to be feared, too, that the links they have forged in the past to bind

to them dominating figures in the share market and in the mining world will not be willingly broken by their old associates. There is a lot of outward lip-service and talk of preference to Great Britain among some leaders here, but it is extremely doubtful if sentiment will be permitted to obtrude in business once the war is over, any more than was done in the past. The prizes are too big to let slip.

A circular issued by the North Broken Hill company contains an eloquent testimony to the way in which the Broken Hill Proprietary company has come to the aid of the mines at Broken Hill. It has undertaken to treat their ores and refine their bullion at bare cost, charging only a commission for selling. The result has been the placing during the past few days of a fair-sized parcel of lead for the North and South companies. It was announced, also, that the directors of the North company, in conjunction with those of the Broken Hill South company, were still negotiating for acquiring an interest in the Port Pirie works of the Proprietary company. As a reminder that there were other Richmonds in the field the directors mentioned that they could not deal with proposals made to join in the erection of works in England or Wales till the negotiations with the Proprietary company were ended. Whether these will come to anything only those in the inner ring know, but an advance in the price of the shares of the three companies seems to point that way. All the same, it is discreet to have a new love on before the old one is off. Of course, a trump card in the form of an export duty on lead is always in the pack, available for use should there be an attempt to transfer lead-smelting across the water, and it would not take much to persuade Labour to play it.

The Australian gold production, unfortunately just when the Labour Ministry is plunging into a big paper issue, continues to dwindle. There is not a district where new shoots of ore promise to make up the shortage in older centres like Charters Towers, Ballarat, Bendigo, Beaconsfield, or in parts of Western Australia. The famous Long Tunnel mine at Walhalla, Victoria, after paying £1,250,000 in dividends, has had to shut-down. The State advanced £15,000 to enable a new company to test the lode at depth, conditionally on the shareholders spending an equal sum, but results were disappointing. It is of interest to note that in this mine, as the lode left the region affected by surface-water and away from the dike with which it was associated, gold contents fell steadily. The only district of any promise in Victoria just now is Ararat, where extensive work is proceeding in the Langi Logan group of deep-lead mines. No one can tell yet what the results will be. If the preliminary clean-ups are low, much capital will be swept into the sluice-boxes for ever.

The gold yield for Australia for 1914 will surely show a decrease. An approximation of the output for the year can be made, though only a part of the December's returns are available. The estimate is 2,023,700 fine oz., and it compares with the yield for the two preceding years as follows:

	1912 oz. fine.	1913 oz. fine.	1914 oz. fine.
Victoria	480,131	434,932	417,300
New South Wales...	165,295	149,657	120,000
Queensland	347,946	263,343	224,400
West Australia	1,282,658	1,314,044	1,233,000
South Australia	7,340	7,292	6,000
Tasmania	37,973	30,000	20,000
	2,321,343	2,199,268	2,020,700

Copper.—The biggest mining enterprise in Northern Queensland is the Hampden-Cloncurry group of mines, which were within the Baillieu ambit. From present indications it looks as if this ever-expanding enterprise will find it extremely difficult to live up to expectations. Recent reports show that the ore reserves in the original Hampden mine are being depleted, and that the Answer mine is not responding so well to the pick as had been hoped. There is some talk of the big silicious copper-bearing formations at the Pindora leases developing so well as to become a substantial asset. That has to be demonstrated. In the meantime the drain on the rich Duchess mine is continuing, so the management must be praying for a decent find at the Macgregor group or for a widening of the ore-shoot at the Trekelano mine. The board confesses that as things go today it costs, including development, from £50 to £53 per ton to produce and realize blister copper. So it suggests a reduction in the wage of the miner until copper gets to £59 with a refund if the metal should reach £70. Presumably the worker will be prepared to concede something to the company, but he will be more reasonable than he is supposed to be if he assents to the proposals submitted without substantial modifications.

Tin mining in Australia is on the dull side. A great many of the claims treat alluvial, and the drought has cut-off their water supply. In other instances the fall in the price of the

metal and the elimination of markets has compelled a cessation of operations. The Mount Bischoff has resumed work under a special agreement with the men. Prospecting at this mine resulted in the company finding at the bottom of a deep gorge a galena lode carrying rich ore. The extent of this find is questionable.

A Prospector's Camp in Roper River District, Northern Territory, South Australia.
Much prospecting is now being done in the region adjoining the west side of the Gulf of Carpentaria.

TORONTO.

Porcupine.—Although the value of the gold output of the Porcupine camp for 1914 failed to realize the sanguine anticipations formed at the outset, the year was on the whole a satisfactory one, all things being considered, the production being in the neighbourhood of $5,280,000, or about one million dollars over the output of 1913. The number of producing mines was doubled, there being now eight on the list, and the only one that showed a smaller output was the Dome. The more recent monthly reports of this company have been of a disappointing character, showing a marked decrease in the grade of the ore treated, which, notwithstanding the increase in the tonnage milled, has resulted in a fall in the yield. The report for December shows 23,030 tons of ore treated with a production of $81,660 dollars, being an average of $3·53 per ton. During the nine months ending with December, 180,510 tons was milled yielding $788,641, or an average of $4·36 per ton. The stock has in consequence fallen to a new low level in the market, selling below $6, and the policy of the management has been severely criticized by disappointed investors. It is contended that instead of aiming to treat large tonnages of low-grade ore it would be better to develop some of the richer orebodies on the property, and the suggestion is made that inside interests are seeking to depress the stock, which of course is an accusation easily made when things go wrong, but difficult to establish.

In marked contrast to the record of the Dome is that of the Hollinger, the directors of which on January 14 increased the annual dividend rate from 39 to 52%, making the monthly payments at the rate of 4%. The latest 4-weekly report, covering the period ended December 2, showed gross profits of $152,663 from the treatment of 19,673 tons of ore, of the average assay-value of $13·22 per ton, at a working cost of $4·50 per ton. The surplus on hand was $1,286,304. Divi-

dends, at the new rate, will call for the annual disbursement of $1,560,000, which on the present basis of production can easily be maintained. The company will shortly have 80 stamps in operation, and an additional 20 will be installed for the milling of ore from the Acme property. A new electric hoist has been ordered to handle the increased tonnage. The increase in the dividend rate has been anticipated for some time, and the stock has been actively in demand with steady upward tendency, selling around $23.

The annual statement of the Vipond, which will be issued next month, is expected to show between 16,000 and 17,000 tons of ore milled from the time the mill started in September to January 1. The production of gold up to the end of December amounted to about $50,000. The ore reserves above the 300-ft. level are stated at 40,000 tons, averaging $11 per ton. The McIntyre is sinking its main shaft from the 500 to the 600-ft. level. Production is being well maintained, an unofficial statement placing the December output at about $53,000. At the Tough Oakes, in the Kirkland Lake district, the mill is nearly complete, and most of the heavy machinery is in place. It is expected to be in operation by the end of March with a capacity of about 150 tons daily.

Cobalt.—Both bullion and ore are now being shipped freely, last week witnessing a new record for bullion consignments, which totalled 470,231 oz. valued at $230,031. The bulk of them came from the Nipissing, which has for some time been storing its ore. The most important discovery that has lately been made was on the Timiskaming property, where a vein coming in from the Beaver adjoining, where it is being developed on the 530-ft. level, proved to be 5 to 8 in. wide averaging 5000 oz. per ton. It is at present being worked from the Beaver, but a cross-cut is to be run from the Timiskaming workings. The annual report of the Crown Reserve will show a considerable decrease in production, the output having fallen to about 1,500,000 oz. or about 250,000 less than the previous year. The Carson vein only yielded a few thousand ounces, being now almost exhausted. The gold production of the Porcupine Crown, controlled by the Crown Reserve, is given at $667,000, of which about half is profit, while the Drummond Fraction, of Cobalt, operated jointly by the Crown Reserve and Kerr Lake, has merely paid for development. The Buffalo, which is now working with 12 drills, will show a considerable decrease in production for the year, the output being about 1,000,000 oz. as against 1,667,000 in 1913, the mill having been closed down for several months. The low-grade mill is being operated, but no ore is being refined or shipped. Underground development has considerably increased the low-grade ore reserves. The Canadian Mining Corporation, the British company controlling the Cobalt Townsite, Townsite Extension, City of Cobalt and Cobalt Lake, has decided to place these properties under one management, and the position of manager has been given to Charles E. Watson. The Trethewey has taken options on two gold properties adjoining the Huronian Mining company's claim in Gauthier township situated between Tough Oakes and Larder Lake. The claims have good surface showings, but the main consideration was the satisfactory result of operations at the Huronian.

Rutherglen.—A new mining district is being exploited at Rutherglen, 40 miles east of North Bay, Ontario, where prospectors have been at work for some time, and about 1000 claims have been staked. Numerous finds of gold, silver, and platinum have been reported, which, according to analyses that have been published, are rich, but so far official corroboration has been lacking, and most of the current statements are doubtless exaggerated. It was widely announced that radium had been found, and one prospector made a report to this effect to the Ontario Department of Mines, with the object of obtaining the reward of $25,000 offered for the discovery of radium in commercial quantities, but has so far failed to present any satisfactory proof of the alleged find.

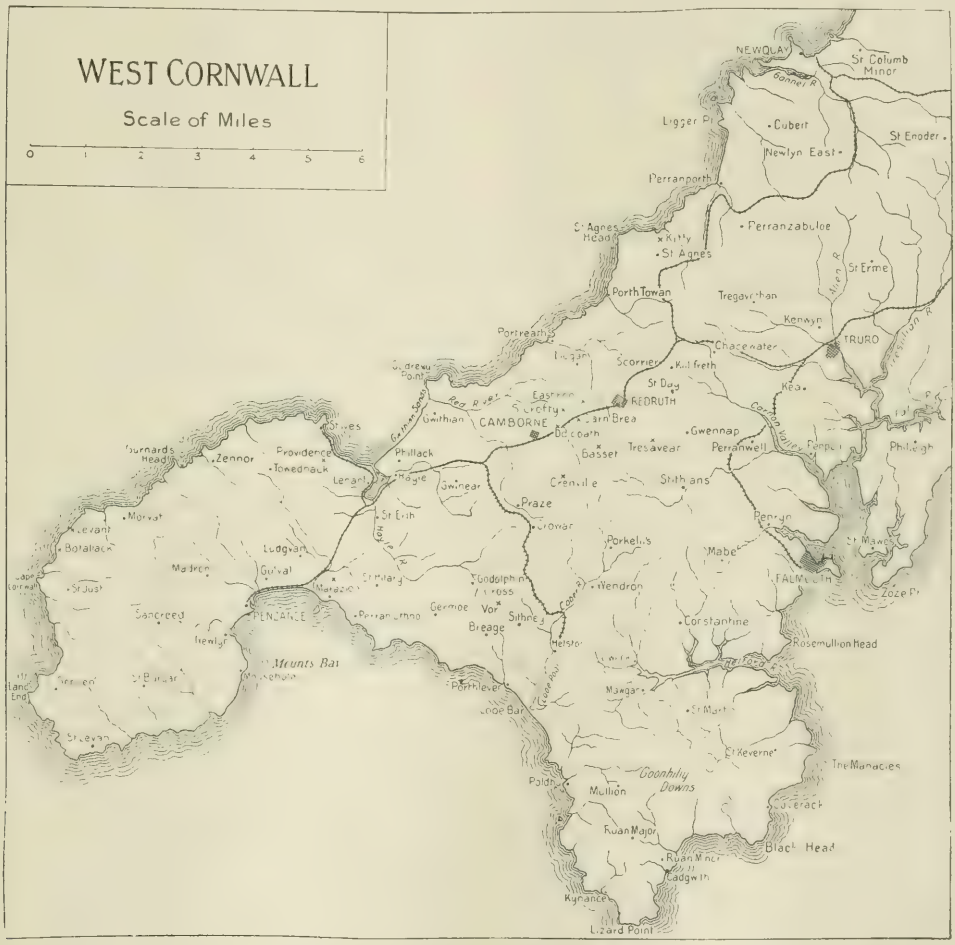
CAMBORNE.

The reports of two of the most progressive of the smaller producing mining companies in Cornwall have been issued recently, and both make encouraging reading.

At Geevor, in the St. Just district, the report is for the twelve months ended September 30, 1914. For that period 25,246 tons of ore was milled, producing 376 tons of black tin, which sold for £34,431, thus realizing an average price of £91. 11s. 5d. per ton. As compared with the previous fifteen months, the average recovery was up nearly 10 lb. per ton of ore milled, and the quantity of black tin sold shows an increase of nearly 85%. But for the heavy drop in the price (nearly £33 per ton as compared with the previous period) a handsome profit would have been earned. As it was, after paying £2442 for interest on

debentures and writing off £1256, the net profit was £2766. The working cost, exclusive of debenture interest and depreciation, figured at 20s. 7½d. per ton. The development equalled about 1 ft. for every 8½ tons of ore milled, which hardly seems sufficient, in view of the narrowness of the lodes. However, this was curtailed because of the war. The mine continues to open up well, and the manager, W. C. Williams, estimates the ore reserves at 60,000 tons, although nothing is said as to the average assay-value of this reserve. It is better to omit all reference to ore reserve in the case of a tin mine, unless its average content can also be given. The price of tin is of such a fluctuating character that what may be regarded as a profitable reserve today may not be so with the price £20 lower. If the assay-value is given, and the working cost is known, anyone can figure for himself when the unpayable margin is reached.

Wheal Kitty and Penhalls is the other company referred to in my opening sentence. The report in this case is for the six months ended December 31 last. The profit earned is £735, and a 10% dividend has been declared on the preference shares. The tonnage treated for the six months was 9670, from which 155½ tons of black tin was produced and sold, which gives an average recovery of 36 lb. per ton. This compares with 132½ tons the previous half-year from 9645 tons of ore. The average price secured was £82. 6s., or £15. 12s. per ton less than in the previous half-year, so that had the price of the metal been maintained, here again a substantial profit would have been earned. It is satisfactory to note that as compared with two years ago the production has been increased over 100%. The development was 1 foot for every 5½ tons milled, but as the lodes are very narrow, this is not so high as it at first sight would appear, although



it is certainly a safe average. The working cost was 25s. 8d. per ton, including development, but not depreciation, but no doubt the installation of the new mill (the erection of which has been postponed owing to the crisis) will reduce this considerably. The mine continues to develop satisfactorily, but it is evident that the ground is much dislocated by slides and cross-courses, so that a vigorous rate of development must be maintained if the returns are to be kept up. It is satisfactory that the lords of the mine have consented to a permanent reduction in the maximum royalties from one-twentieth to one-thirtieth of the value of the produce. This is a striking contrast to the attitude of the mineral owners of some other mines in the County.

Levant.—After eighteen months this mine returns to the list of profit-earning concerns, partly because of an increased production, but chiefly because of the better price realized for its main product. Being a cost-book company, the statement of account is presented each 16 weeks, and that under review is for the period ended January 16 last. The tonnage milled was 9354, and the quantity of black tin sold 163 tons, which gives an average recovery of 39 lb. per ton. In addition, small quantities of copper and arsenic were sold. The average price realized for the crop tin was £82 per ton or £6. 4s. 6d. higher than in the previous period, while the quantity was up 11 tons. The profit earned was £1386. The meeting not having been held, no information is available as to the renewal of the lease, which expires shortly, but it is to be hoped that the mineral lords in these times of stress will even yet take up a reasonable attitude and renew it on equitable terms. It would be nothing short of a disaster to the St. Just district if this famous old mine is abandoned at such a time.

Tin Dressing. — Some interest has been evinced of late in what is termed a new process, invented by Mr. Morley Martin, of Redruth, for the recovery of a higher percentage of the tin content than is possible by existing mechanical means. The principal feature appears to be the use of tables, the surfaces of which are covered with finely divided glass so as to assume the appearance of frosted glass, giving a scientific surface for the retardation and deposition of the tin, whether in the form of sand or slime. The majority of tin-dressing experts in the County seem sceptical of the experimental results secured by Mr. Martin, but the process is soon to be tested on a commercial scale at Carn Brea, where one or more of the new tables are being installed. An experimental plant is also to be erected at the inventor's expense at Wheal Kitty, to treat the effluent from the dressing plant on that mine, so it will soon be known if the inventor's claims are justified.

Dissatisfaction is again rife among Cornish mining companies as to the price received for their tin concentrate as sold at the ticketing, and efforts are being made to resuscitate the idea of a co-operative smelter, the capital of which would be provided by the mining companies. As a matter of fact there seems to be less cause of complaint in this respect now than was the case before the outbreak of war. Those interested in this subject are referred to the article by Mr. H. E. Fern written in this Magazine two years since, when he gave figures which were not disputed, showing the advantage of a private contract over the method of sale at the ticketing. The demand for English tin has compelled the smelters to pay better prices of late, but certainly the method of sale by ticketing is antiquated, unsatisfactory, and one where the smelter scores every time.

The smelting works at Hayle, owned by Williams, Harvey & Co. has been closed, and the business has been entirely transferred to their Bootle works, which are the most modern in this country.

NEW YORK.

Copper. — Little apparent progress has been made toward the settlement of the question of American exports of copper to Europe. Downing Street and our State Department are still exchanging notes that have so far had no visible effect upon the refusal of some of the shipping lines to accept consignments of copper at all, and the greatly increased freight-rates charged by other lines. Sales to England and France continue large, but orders from other countries are much affected by the doubt whether the metal can be delivered. Over 30 shipments, aggregating some 45,000,000 lb. of copper are still detained, some of them having been held since August 15. This delay not only causes a large loss in interest to the sellers but makes it difficult to accept orders, as no one knows just what is permitted. Exports for the week ended January 23 were the highest of any since war was declared, but even at that they were only slightly in excess of the average weekly rate for last year, although the shipments to France for that week were three times the average amount and shipments to England nearly double the

average. There must be considerable stocks of copper still in the hands of the refineries here; nevertheless the price of the metal continues to advance, and if it goes much above 14 cents the principal companies will doubtless begin to increase their output, since consumers have already suggested that the general agreement of the mining companies to cut down their production to one-half normal constitutes a combination in restraint of trade, an offence against our laws governing business that may be severely punished. It would be unwise to allow the price of copper to rise much above normal, if it can be prevented, as the large output of the Chuquicamata mine (of the Chile Copper Co.) will be coming on the market about the middle of this year, and might cause a collapse if the price of the metal were then abnormally high.

Antimony.—The Wha Chang Mining Co. of Changsha, China, the largest individual producer of antimony in the world, has opened an office in New York for the sale of its product and is beginning to make contracts with consumers both here and abroad. For some years the Wha Chang Company has been marketing its metal through the New Chinese Antimony Co., Ltd., a subsidiary formed by the Cooksons to handle this business. The contract between the two companies provided that settlements should be made on the basis of the daily Metal Exchange quotations in London, though the Wha Chang company reserved the right to sell to any outsiders who offered more than an agreed amount above the London quotation. When the war broke out an embargo was placed on exports of antimony from England, and as considerable amounts of antimony were shipped thither the price of the metal was depressed. In New York, where big stocks of the metal had accumulated in the hands of speculators, prices rose rapidly under the impetus of large orders for quick shipment to foreign countries, so that the reserves were speedily cleared off at good prices. The Wha Chang company, not unnaturally, was unwilling to continue to deliver metal to the new Chinese company on the basis of London prices, and ceased making shipments to the latter. The demand for antimony continues good and it is understood that orders have been booked for shipment direct to Russia from China by way of Vladivostok, and that consumers here are also placing orders with the Wha Chang company. The establishing of this sales agency in New York is an excellent move, since the marketing of antimony here has until now been chiefly in the hands of brokers and speculators and the considerable fluctuations in the price of the metal due to their activities were not to the advantage of either the consumers or producers of antimony, both of whom would prefer a steady and reasonable price for the metal.

Alaska.—At a special meeting of the shareholders of the Alaska Gold Mines Co., held on January 21, an issue of $1,500,000 of 10-year 6% convertible debentures was authorized, the capitalization of the company being increased from $7,500,000 to $10,000,000. Of the new shares 50,000 will be set aside to provide for the conversion of the bonds, and the remainder will be held for the conversion of any possible future issues. In a recent statement sent out by the company it is set forth that the average grade of the ore so developed has proved to be higher than the $1·50 per ton of the first estimate, and the tonnage developed is also larger than expected. The mill is now about ready to start and is expected to handle 8000 tons of ore per day, though it was designed for only 5000 tons. It is quite probable that the milling capacity will be increased at an early date. Alaska Gold Mines shares are being quoted at about 2½ times their par value, and it is interesting to note that the valuation thus placed on this one mine is about three times the sum that the United States paid to Russia for the whole of Alaska, a transaction that was generally described at the time as 'Seward's folly.' To this must be added the Alaska Treadwell, Alaska Mexican, Alaska Juneau, and the probable value of the Ebner, the placer gold recovered at Nome and elsewhere, the copper, oil, and coal deposits of southeastern Alaska. Surely W. H. Seward made a great bargain.

Engineering Foundation. — Ambrose Swasey, of the firm of Warner & Swasey, instrument makers of Cleveland, Ohio, has given $200,000 to establish a fund to be known as the Engineering Foundation, to be administered by a board composed of 9 members elected by the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and 2 members chosen at large. The fund is to be "devoted to the advancement of the engineering arts and sciences in all their branches, to the greatest good of the engineering profession, and to the benefit of mankind." It is evident that the field of work that may be undertaken by the terms of the gift is wide.

METAL MARKETS

COPPER.

Average prices of cash standard copper:

Jan. 1915	Dec. 1914	Jan. 1914
£60. 17s. 7d.	£56. 18s. 5d.	£64. 8s. 0d.

The market has shown a substantial rise during the month. An increase of over £7 per ton in prices during war-time with the principal European consuming country debarred as a purchaser must be considered a notable achievement. The demand of course is principally for war purposes, although it is remarkable that the electrical industry continues to buy, in this country at least, in no less quantity than before the war. The amount absorbed here for military purposes more than compensates for the decreased requirements in other countries. This fact, coupled with the increase in freightage charges, is largely responsible for the appreciation in price. As is well known, the American output was curtailed on the outbreak of hostilities, but the demand appears to have outrun the diminished supply, and inducement for American mine-owners to increase their output will no doubt be found not only in the enhanced price but also in Government pressure. The rise for this reason is probably overdone, and a slight reaction is therefore probable. It should not be considerable or of long duration, however, for the growing activity of the world's arsenals is becoming more feverish.

A good deal of copper—chiefly Japanese and African—which formerly was marketed on the Continent is finding its way to this country.

TIN.

Average prices of cash standard tin:

Jan. 1915	Dec. 1914	Jan. 1914
£156. 14s. 6d.	£147. 4s. 4d.	£172. 0s. 11d.

The market for this metal has presented remarkable features. Commencing at £142 for three months the price gradually began to climb until £162 was reached late in the month, and then suddenly collapsed to £152. 15s. The spot price however remains strong, and closes at the top, £176. 5s. This feature is generally attributed to the delay in discharging tin shipments in London. But a heavy backwardation is not new in the history of tin prices, and points to the market being under strong control. American operators appear to be against a rise in prices, and have resold to London, but it is not likely that their requirements are less than normal, for there must be heavy demands for the canning trade. A novelty has appeared in a good demand from Scandinavia which has given rise to some suspicion; the explanation is that the ultimate consumer is Russia, and that Scandinavian countries have now to obtain supplies here which hitherto reached them from Germany. The new trade is hedged by so many difficulties that no considerable business is likely to develop. Operators express themselves as uneasy at the accumulations of Banca tin in Batavia; sales have been made of fair quantities at £160, and up to £165.

LEAD.

Average prices of soft foreign lead:

Jan. 1915	Dec. 1914	Jan. 1914
£18. 12s. 0d.	£18. 18s. 4d.	£18. 19s. 9d.

Prices have ruled fairly steady at about £18. 7s. 6d. to £18. 15s. Demand for sheets is almost nil, but on the other hand the quantity required for warfare is unprecedented, and the heavy tonnage reaching this market is readily absorbed. Russia has taken, and still continues to require, large amounts, which reach her by direct shipment from the producing countries. France is also reported to be in the market, but shipment is exceedingly difficult to arrange on account of the congestion of her principal ports. America's price has been raised to 3·80 cents, which is above London parity.

SPELTER.

Average prices of good ordinary brands:

Jan. 1915	Dec. 1914	Jan. 1914
£30. 16s. 1d.	£27. 6s. 10d.	£21. 9s. 9d

Spelter shows an advance of £10 for the month. With continental supplies all but stopped we are almost entirely dependent on America for this metal. Fortunately the galvanized trade is dull, but the demand for good quality spelter for brass-making is likely to strain the resources of the American refiners. To conserve the supplies for military use it may be necessary to revive the spelter committee, abolished when prices showed a decline after being in existence for nearly four months. It is highly desirable that some plan be devised to smelt Australian concentrate in this country. The difficulties are considerable, but we hope not insuperable.

OTHER METALS:

Quotations on February 8: Antimony, £73 per ton; nickel £185 to £200; aluminium, £81; quicksilver, £11. 10s. per flask; platinum, 185s. per oz.; silver, 22½d. per standard ounce.

THE MINING OF ALLUVIAL DEPOSITS. I.

A Discussion of the Relative Advantages of Various Methods of Treating Alluvial Deposits.

By NEWTON B. KNOX AND CHARLES S. HALEY.

THE first of this series of articles is devoted to those physical factors that affect the choice of any particular method of mining alluvial deposits, and their relation to one another. In the second portion, we shall treat the different methods of examination of alluvials and discuss the operation of both power and hand drills. In the third portion, we shall confine ourselves to the literal meaning of the word 'exploitation,' saying more concerning installation than subsequent operation. The subject of operation is too big for an article, and, moreover, dredging has been already so ably described in other publications* that a detailed description of it would be superfluous. Hydraulicking has been treated in detail elsewhere; also drifting. We do not intend to refer to Russian methods, including the use of horse-scrapers, horse-carts, and butara-washing, all of which have been described in recent publications.

The most important methods of alluvial mining are dredging, hydraulicking, and drifting. Each has its modifications. The employment of any one of these methods is based upon certain sets of physical conditions, the most vital of which is, of course, the valuable content of the material to be treated. The relative importance of all other conditions is dependent upon this. Adverse conditions in a low-grade property would cease to be prohibitive in one of higher tenour. In determining the importance of these conditions to each other and to the whole, the judgment and experience of the examining engineer is subjected to a severe test. The larger proportion of failures can be traced directly to either a misreading or a disregarding of the governing physical factors and their effect upon the choice of the mechanical means to be adopted. In other words, the ground may be unintelligently prospected, prohibitive features may be neglected, the wrong method of mining may be adopted, and, lastly, a totally inadequate equipment may be provided. Such blunders spring mainly from the failure to realize the important part experience plays in this class of mining. The examination of alluvials has often been left to drillers or dredge-masters. Indeed, cases are known where advice has been sought in alluvial problems from engineers whose experience has been limited to lode-mining.

*D'Arcy Weatherbe: 'Dredging for Gold in California.' Published by the *Mining and Scientific Press*.
Charles Janin & N. B. Winston: 'Gold Dredging in California in 1907'; published by the California State Mining Bureau.

Dredging.

Gravel deposits in rivers that have worn down their gradient to the basal plane, as at Marysville, California; or mountain streams at the point where they debouch into the main central valleys and there deposit their burden, as at Oroville and Folsom; and meandering rivers bordered by the broad flats of their peneplain, as on the Pato, in Colombia, form the most favourable types for the bucket-dredge. Ideal dredging ground may be furnished in each of those cases. It should possess the following characteristics: Gravel loose and uniformly small, yet sufficiently impervious always to retain water sufficient for the dredge-pond; a depth varying from 40 to 60 ft.; a bedrock that is soft and decomposed; an absence of barren top-soil, extensive beds of sticky clay, cemented gravel, or barren sand; no living or buried timber; and a fairly uniform distribution of metal throughout the gravel. The river should not be subject to sudden or extensive floods. In addition to these factors, availability of power, either water or steam, and accessibility to transport, with its consequent low freight-rates, should exist. The deposit should be situated in a temperate zone, preferably. These salient features are further amplified, and the limits that they govern are set forth in the following paragraphs.

Gravel. — In dredging parlance, small gravel means that the largest stones are smaller than a man's head. Boulders vary from two feet in diameter to the size of a small house. Most of the records for yardage have been made in California on small gravel; but on the Trinity river there is a dredge operating on ground that contains boulders weighing over a ton. As a general rule, unless the deposit is unusually rich, it is

unwise to attempt to dig into ground containing nests of boulders. Under such conditions repairs to the bucket-line are frequent and costly, and the recovery of gold under boulders lying on bedrock is small.

An excess of cemented gravel or stiff clay means reduced yardage and expensive repairs. At Folsom, however, some of the ground that is being dredged by the modern boats is cemented. Sticky clay means reduced capacity, due to difficulty in discharging the buckets. It is also a source of considerable annoyance in the sluices, where it is known as 'robber' clay, because it removes amalgam. Some troubles due to clay can be overcome by the use of log-washers on the dredge; but extensive beds of sticky clay, even when of a high gold content, as those on the coast of Brazil, are undredgable.

FIG. 1. HOME-MADE HYDRAULIC ELEVATOR, FORKS OF SALMON, CALIFORNIA.
Note position of the hydraulic giant that feeds the Elevator at the right of the picture.

The gravel should be sufficiently water-tight to hold its dredge-pond; for a sudden emptying of the pond might bring disaster to the dredge. Also, it is sometimes necessary to maintain the water in the pond at a different level from that of the surrounding country. It may here be mentioned that a 7-ft. dredge requires ordinarily fifty inches of fresh water continually for wash-water and to keep the level of the pond constant.

Depth.—Deep gravel (60 to 70 ft.) of sufficient acreage is ordinarily worked in California by the large 15-ft. dredges. However, in our opinion the size of the dredge should not be dependent upon the depth of the gravel alone, for it might be good policy to erect a dredge of large capacity upon a deposit 40 ft., or even 20 ft. deep. Gravel of a depth of only 10 ft. would call either for a very small dredge, or preferably for the adoption of another method of working; such as, for instance, the drag-scraper. The term 'depth of gravel' must not here be confused with the 'digging depth,' which means the depth from the surface of the pond to bedrock. For instance, in California a 5-ft. dredge is working in gravel 38 ft. deep, and carrying a 20-ft. bank. Hence it is only digging at an 18-ft. depth.

Bedrock.—The ideal conditions call for a soft bedrock without ridges or crevices. In a granite country the bedrock under the gravel is usually decomposed to the required softness. The same thing is true of some sandstones and porphyries. A limestone or slate country is nearly always characterized by a hard, blocky, or knobby bedrock, often with deep crevices. These latter types are quite unsuited for dredging, as the wear on the bucket-lips is excessive, and the gold lodges in crevices beyond their reach. A false bedrock, such as the one of volcanic ash at Oroville, is ideal. The presence of boulders of the country-rock of the district is usually an indication of hard bedrock.

In judging the hardness of bedrock, the evidence derived from shafts or drill-holes should be accepted in preference to that pre-

sented by exposures in running streams or water-courses. Cases have been known where bedrock seen in the river was found to be hard; whereas the drill proved that the bedrock underlying the gravel was soft and decomposed to a considerable depth. In this case the denudation caused by the running water was greater than the weathering, and all products of the latter were swept away. Under the gravel, however, all decomposed minerals were intact, and formed the soft layer encountered by the drill.

Timber.—One of the chief drawbacks to dredging in tropical countries is the presence of buried timbers, as in French Guiana, and sometimes in Victoria. They are a source of considerable annoyance; indeed, if in great quantity and well preserved, their presence will prohibit successful dredging. Dredges built for tropical work should always be equipped with derricks and stump-pullers. In California, gravel is singularly free of buried timbers; but standing timber is not uncommon, and unless the gravel is sufficiently deep to spread the cost of clearing and stumping over a large yardage, this feature also adds materially to operating costs.

A deposit ten feet in depth, for instance, with a forest of large and deep-rooted fir-trees upon it, would require a high gold content to offset the extra cost of clearing.

On the other hand, the dense jungle-growth of tropical rivers is often misleading, for, while thick to the point of being impenetrable, these jungles can be quickly and cheaply cleared, the roots of the larger trees being close to the surface. In Colombia, where native wages are two shillings per day, an acre of ordinary ground can be cleared and stumped for about five pounds sterling.

Gold.—The gold should possess three appreciable facets, and be readily amalgamated. It should not be too finely divided, as in the case of the Snake River gold; and it should be distributed with some uniformity throughout the gravel. Coarse gold confined to bedrock is usually an indication that the ground is patchy, and, unless the bedrock is soft, its recovery is difficult. It is unusual for top soil to carry gold in profitable quantity. Extensive layers of sand are nearly always barren, and a deposit in which much sand occurs is apt to be patchy.

Climatic Conditions.—Deposits situated in extreme latitudes often contain permanently frozen gravel, which can be dredged only by previously thawing with steam-points. In Alaska this type of ground is being dredged at a cost of 27 to 30 pence per cubic yard. Aside from the question of accessibility, dredging in these latitudes is greatly hampered by the short seasons, necessitating either the engaging of a new staff each year, or their maintenance during the idle season. Cold climates also mean a more expensive dredge, necessitating the installation of a heating apparatus and the housing of the exposed parts of the stacker and bucket-line. Flood-

Fig. 2. Back-Splash from Striking-Plate at top of home-made Hydraulic Elevator, Forks of Salmon, California. This elevator has no throat, being merely a jet confined in a steel sluice-box.

ing of the ground to be dredged is also necessary.

Dredging in the tropics likewise is a costly business, owing to climatic conditions, with their accompaniment of malaria and other fevers, which necessitate a reserve staff and the payment of higher wages. The usual inefficiency of the native labour also adds greatly to the cost.

Floods.—To attempt to dredge in torrential rivers, characterized by sudden and extensive floods, is always hazardous. Many dredges

have been swept away and wrecked by a rapid rise of the water. This question of floods is one that should be most carefully investigated, and data regarding it should be collected covering a number of years. As a general rule, it may be stated that rivers flowing through narrow canyons are always perilous. Even rivers with adjacent flats, when in countries where cloud-bursts are frequent, are also liable to floods. Profitable dredging ground bordering on flood-rivers is often worked by dredging inland and keeping a barrier of unworked ground to serve as a levee between the working-face and the river. This method of dredging was employed at Marysville at the beginning of dredging operations there.

It may be stated that most of the dredging and hydraulic operating practice mentioned in this paper is drawn from the California region, and that while some years ago California could be instanced as offering almost ideal facilities for dredging, this is no longer the case. With the exhaustion of the more easily worked deposits, many dredges have been, and will be, thrown on the market. In some cases, these have been installed on properties formerly considered undredgable. The promoters of such enterprises realize that even if failure should ensue, they would only lose the price of a second-hand machine. In consequence of this policy, it is unsafe to assume that all California dredges are now working on ground of a character that could be safely exploited elsewhere. The bouldery ground being worked on the Trinity river is a case in point. A dredge now being erected on the American river, whose flood-plane is in places 30 ft. above the normal, gives promise of a precarious future.

Transport.—The importance of freight-rates weighs more heavily with this class of alluvial installation than any other. For instance, a 7-ft. close-connected dredge of the California type, complete with spares, steel pontoon, motors, generators, and repair-shop fittings, weighs about 1000 tons. Some of the single parts weigh 12 tons, and in larger dredges up to 17 tons. This being so, the necessity of easy access to the property is apparent. Deposits reached by trail are quite prohibitive, and the dredge sectionalized for muleback transport has yet to prove itself a success. Not only do excessive freight-rates affect the first cost of a dredge, but they can be felt during its whole operating life. We would hesitate to recommend the erection of one of the larger dredges (11 to 15 and 16 cu. ft.) far from civilization. Even the cost of a 7-ft. boat is enormous. A case in point is the recent completion of a 7-ft. steel pontoon California-built dredge in South America, the cost together with that of power installation and buildings being close to £240,000. It may be added that this excessive cost was due partly to ignorance of local conditions in the tropics.

The cost of transporting bulky pieces of machinery is suggested by the following case: From Colon to Puerto Colombia the United Fruit Co. charges a flat rate of $5 per ton for freight. All pieces weighing over 4 tons must pay an excess rate of 150%; over 8 tons, 200%. A similar excess tariff is charged on the Barranquilla railroad and the river-steamers up the Magdalena.

Labour.—The amount of labour required on a moderate-sized electrically driven dredge of the California type may be enumerated as follows: One dredge-master, three winch-men, six oilers, two mechanics, and several roustabouts. The latter may be natives; but in countries where skilled labour is lacking the remainder of the crew, with the possible exception of the oilers, must be imported. In addition, a staff for the electric or steam-power plant and the shops must be considered. However, for the amount of material handled by a large dredge, its labour-cost per yard is low.

Countries.—The customs of the people of the country sometimes appreciably affect working costs. For instance, in Russia, the frequent holiday with its inevitable 'morning after,' the Government enforcement of various annoying regulations, such as the pay for the mining inspectors, doctors, and other officials, and the fund set aside for the entertainment of these officials on their visits; all must be seriously considered. The question of customs-duties on mining machinery should also be investigated; and, it goes without saying, the bullion-tax and security of titles.

Hydraulicking.

Method. — The term 'hydraulicking' is used here to designate that class of mining employing the use of water under natural pressure in giants or monitors, and disposing of the tailing by gravity. Next to the question of gold content, the determining factors in the employment of this type of mining are the presence of an abundance of cheap water that can be brought to the mine under pressure and the existence of sufficient grade for dumping the tailing. These and other factors vital to the successful working of a hydraulic mine are here amplified.

Gravel.—The size of the gravel does not

play such an important role in hydraulicking as in dredging. Much larger boulders can be handled, provided there is room for their disposal. Fairly tight layers of clay and cemented gravel can be first shattered and then disintegrated by the giant. Gravel of 600 ft. or even greater depth has been worked; in fact, with the use of a benching system, there is practically no limit to the depth of bank that can be exploited. Of course, other things being equal, the smaller and looser the gravel the higher will be the duty of the water.

Bedrock.—The influence of bedrock is not so important in hydraulicking as it is in dredging; yet an ideal bedrock is one that is even, not disintegrating, soft enough not to cause too much expense in cutting sluices and still hard enough for easy cleaning. It is a great help if the natural grade of the channel assists in setting sluiceways. A deeply shattered bedrock is difficult and expensive to clean, as the gold finds its way deep down into the crevices.

In this connection a type of granite bedrock known in South America, and other places where the rainfail is heavy, may be mentioned. It weathers underneath the gravel to depths of five or ten feet, and forms a soft, hummocky 'underburden' to the deposit, all of which, though absolutely barren, must be cut and washed away in order to insure the recovery of the bedrock-gold, lying for the most part on top of it, and at the bottom of the gravel.

Water.—The existence of an ample and cheap water supply is imperative for this class of mining. On the question of water depends in great measure that of the duty and subsequent operating cost. The character of the ground through which the ditch has to be run should be carefully considered as to seepages, slides, footings for flume-posts, cross ravines, general liability to wash-outs, and its ability to withstand erosion.

Effective heads range from 200 to 600 ft. Below the former figure the duty is apt to be low; above the latter the requirements of extra heavy pipe, anchorage, and bracing, become exacting. Within limits the amount of water required varies inversely with the head obtainable. With a 200-ft. head, a flow of 2000 inches would suffice to operate a moderately sized mine; while with a 400-ft. head, 1000 inches would give nearly the same output, the gravel being loose and free.

Few hydraulic mines are so situated that a full head of water is obtainable throughout the year. Consequently part of the excess of water during the season of greatest flow is conserved, wherever possible, in storage reservoirs. When the supply becomes low, these are frequently allowed to fill during 12 to 20 hours per day, the water being only used for a short interval.

Where it is impossible, from the contour of the country, to obtain water under a natural head of any magnitude, attempts have been made to substitute artificial pressure from pumps. This is only practicable where water-power is cheap as well as abundant. The most noteworthy recent instance of large-scale operation of this sort is the hydraulic work done on the Panama Canal, where sea-water was used under pressure for cutting down the material with giants, centrifugal pumps being employed to elevate and discharge the material. The latter was chiefly silt and fine sand, but even there the duty was low and the cost fairly high. While such installations may prove successful mechanically, they have in most instances been failures financially.*

The duty of water, in cubic yards per miner's inch, varies from one to ten, and depends upon the character of the gravel, the facility for disposal of tailing, the amount and head of water available. The employment of 'lead' or 'wash' water will be discussed under the head of 'Operation.'

Timber.—The presence of an ample supply of good timber for construction is more vital than in the case of dredging, as it is constantly in demand for the building and repair of flumes, sluices, trestles, dams, sluice-linings and sluice-blocks, as well as giant and pipe-line bracing. The presence of buried timbers in the deposit is not at all prohibitive in this class of mining, as they can readily be piped out and cut to a size convenient for the derrick. The clearing of a dense growth of standing timber, adds, of course, to the cost of mining.

Debris Laws.—This is a serious factor in plans for hydraulic mining, as the deposition of debris in the streams has been found to be a real detriment to agricultural interests below and to navigation in the streams themselves. In 1893, it was found necessary to prohibit hydraulic mining in many parts of California by the celebrated Caminetti Act. One of the writers of this paper was compelled to decline a promising hydraulic property in Spain,

*C. W. Purington in Bulletin 263 U.S. Geol. Survey, states that, out of nine plants visited by him in Alaska at which pumping, to secure head for hydraulic mining, was in progress, not one was making expenses. See also article on 'Gravel Mining' by W. H. Storms, *Mining and Scientific Press*, Dec. 2, 1911.

owing to the fact that its only dumping facility was in a river that fed a multitude of small irrigation canals. It would have been a question of only a year or two before these canals were silted by mining operations, which fact would have brought down upon the company the passage of a debris law and perhaps heavy damage-suits.

For this reason, in planning the operation of a property, it is important to consider the effect of the disposal of tailing upon farming and other lands. When debris is deposited in one of the tributaries of a river that drains an extensive farming district, with a silting that causes overflows during the flood season, damages are sure to result. The same disadvantage is true of rivers on which are situated irrigation works, dams, and ditches.

An ideal dumping-ground is one like that of the La Grange, in northern California. The tailing passes into a narrow valley about four miles long, which is the property of the company and drains directly into the Trinity river. This river and the Klamath were not included in the prohibition of the debris law. They are torrential streams, and the damage done by hydraulicking to the farming interests is practically negligible.

Labour.—After the equipment and installation of a hydraulic property, the question of labour is fortunately not a serious one, as but few skilled men are required. Six pipers and 4 or 5 ditch-tenders, a good blacksmith, and perhaps a winch-runner, are all that are required on a mine of moderate size.

Transport.—One of the chief advantages that hydraulic mining has over dredging is the fact that it is not so greatly affected by the cost of transport. It has been pointed out that a 7-ft. dredge complete weighs nearly 1000 tons; whereas the equipment of a hydraulic mine handling the same amount of gravel, complete with giants, pipe, gate, sawmill, derrick, tools, etc., weighs under 100 tons.

Besides the cost of equipment in the subsequent running of the mine, that of supplies and spares amounts to a comparatively small sum, most of the repairs being made by the blacksmith. For the above reasons, and owing to the fact that all equipment can be shipped in small packages, a hydraulic mine can readily be operated in districts reached only by mule-trail. Where timber must be brought, the question of transport becomes much more serious; so serious, indeed, that it may in some cases prove prohibitive.

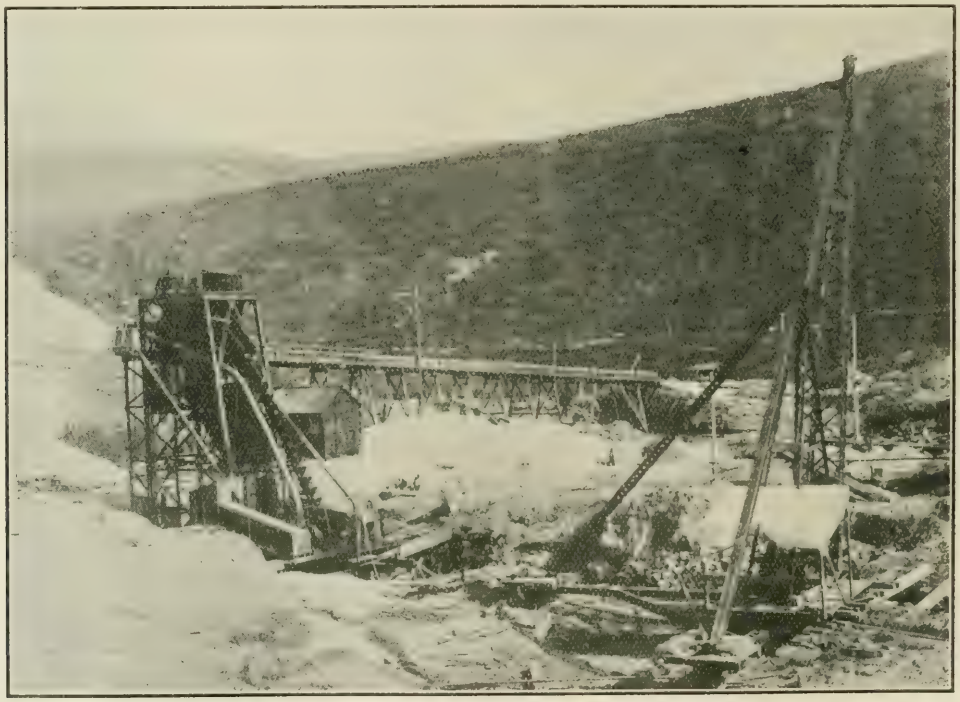


Fig. 3. Yukon Gold Company's Mechanical Elevator, Dawson.

MODIFICATIONS OF THE ABOVE METHODS.

Pump-Dredging.—This method was devised to meet certain conditions existing in New Zealand and Australia; conditions that prohibited the employment of either bucket-dredging or ordinary hydraulicking. The most important factor governing the choice of this method is the character of the bedrock.

Where the gold is concentrated on or near a bedrock that is rough, hard, and uneven, or where it is deep within the crevices of a shattered or broken bedrock, it is necessary to expose and clean the rock carefully. This, of course, prohibits bucket-dredging. If the deposit be too low for hydraulicking, other means must be adopted. To meet these conditions, what is known as the Australian pump-dredge has been devised. This so-called dredge (for in the true sense of the word it is not a dredge) is a set of centrifugal pumps mounted on pontoons that float only when being changed from one working-face to another. It is, in a measure, a connecting link between bucket-dredging and hydraulicking. By the use of it, bedrock is exposed for cleaning, so that all the disadvantages mentioned above can be overcome. The first cost is much less than that of a small bucket-dredge, which fact renders it more feasible for working small areas of ground.

This method is also used effectively where the gravel is deep and no dump is available. Or if the deposit be of average thickness (say 25 ft.) with its valuable wash lying between a hard uneven bottom and a tough bouldery overburden, the pump-dredge is applicable. It must be borne in mind that a limiting factor is the amount of water in the ground. If there be too much water, the power required to drain the ground is excessive; if too little, the time required to fill the pit becomes too great. Where much buried timber is encountered, this method also applies. Where transport is a serious problem, the lightness of the pump-dredge and its simplicity of installation, compared with that of the bucket-dredge, may render it suitable in spite of the fact that all other factors for successful bucket-dredging may be present.

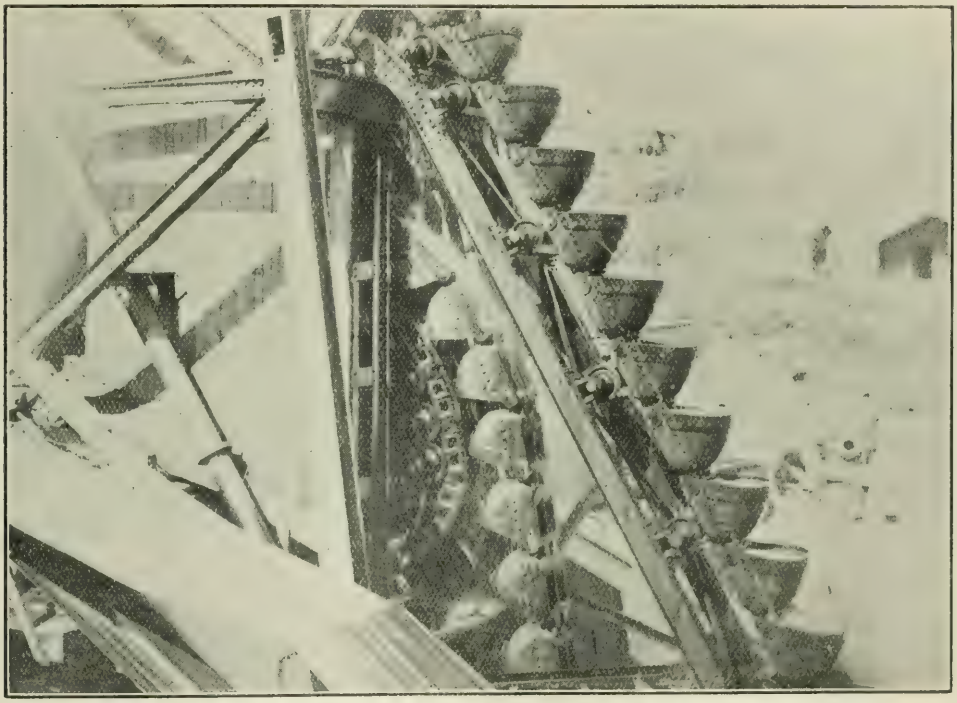


FIG. 4. DETAIL OF YUKON GOLD COMPANY'S ELEVATOR.

Hydraulic Elevators.—Where all factors calling for the employment of hydraulic mining are present, with the exception of dumping facility, this adverse condition can sometimes be overcome by the use of the hydraulic elevator.

Cheap and abundant water under great pres-

sure or cheap fuel are essential. This is due to the fact that the efficiency of these machines is notoriously low. The lifting power of the elevator is from one-sixth to one-tenth the head employed; the proportion of solids in the total weight of material lifted is at most 5%, the remaining 95% being water. It is largely due to these facts that mining by this method has been a failure. Another factor requiring consideration is the size and amount of boulders in the ground. Ordinarily, with an ample supply of water, in regular hydraulic mining, the size of the boulders that can be ejected through the sluices is in the main limited only by the width of the latter. In hydraulic elevation, however, the limit is governed by the width of the throat of the elevator; consequently, as this, even in a large elevator, is not more than 15 inches, all boulders of larger diameter must either be blasted or handled by the derrick and stone-boat. Consequently only ground containing moderately small gravel is adaptable to this method of treatment. (See Figs. 1 and 2).

Grizzly Elevator.—When a deposit of gravel not exceeding 50 ft. in depth lies on a hard bedrock with little or no dumping facility, and the water supply is limited; and when nests of heavy boulders exist, a modification of the hydraulic method with the adoption of an inclined grizzly or of a simple inclined sluice may be advisable. The former, sometimes called the Ruble elevator, will be described in detail later. By the use of it all the heavy tailing is stacked and left on the worked-out bedrock. The grizzly is unsuitable on rough and extremely wavy or uneven bedrock, owing to difficulty in moving. Its chief advantage over all other forms of elevator lies in the low cost of construction, as well as the fact that it can be made on the ground. Another point in which it excels is its capacity for handling heavy boulders.

The Inclined Sluice is employed to elevate material that has already passed through a string of sluice-boxes. Small deposits in Northern California and Southern Oregon have been worked by this method, and recently it has been successfully adopted to exploit the small holdings in Circle and Forty Mile districts, Alaska. On Mastodon Creek, Circle district, a small plant is in operation which may be cited as an example of this practice. Here two No. 1 giants and one No. 2 giant are operating with water under 100-ft. head. The sluice-boxes (30 in. wide), of which there are six each 12 ft. long, deliver their tailing into a common sump; from here the tailings are stacked 35 ft. high through an inclined sluice by the No. 2 giant.

The depth of the gravel is 9 ft. and the duty, including the water used for stacking, is $2\frac{1}{2}$ cu. yd. per miner's inch of 20 hours. Fairly heavy slabs of bedrock are raised by the giant. The crew consists of 6 nozzle men and 3 rock wheelers.*

Mechanical Elevators.—Attempts have been made, from time to time, to overcome the lack of sufficient dump by means of mechanical elevators of the stacker or belt type. These machines have been expensive in their first cost, erection, maintenance, operation, and moving. They have never been, as far as we are aware, a financial success. However, inasmuch as no serious mechanical problems are involved, we see no reason why a successful machine of this type cannot be designed, constructed, and operated. It should be lighter than those already attempted and consequently more mobile.

A mechanical elevator was erected about six years ago on Bonanza creek.† This was made of a frame of steel 49 ft. high, mounted on wheels. The gravel was elevated by a bucket-line of close-connected type, 76 buckets in all, each with a capacity of 3 cu. ft. These discharged at right angles into the sluice-box at the rate of 26 per minute. The power was 200 h.p.; 35 for the bucket-line and 165 to 175 for the pumps. The actual capacity per day was 1500 cu. yd. The first cost of this machine was high, and in actual running it proved costly in operation and repairs. (See Figs. 3 and 4).

At Beauceville, Canada, a mechanical elevator was erected, by the New York Engineering Company (see Fig. 5), at a cost of £5000. Its elevating height was 50 ft. from bottom of sump to top of bucket-line. It was equipped with 150 h.p., of which the bucket-line ($3\frac{1}{2}$ cu. ft. close-connected) consumed 50 h.p., the remainder being used to operate the 14 in. centrifugal pump. Its capacity was 2000 cu. yd. per day. The cost per yard is given at 6d., which high cost was due to expensive electric power. The machine was mounted on wheels that ran on rails. Its elevator could be raised and lowered by a winch. The plant was in operation 18 months. Failure was due to high cost and low-grade gravel.

The most elaborate example of this type that has come under our notice was the plant of the Tarr Mining Co. at Smartsville, Cali-

*Herbert J. Ellis, Hydraulic Mining at Circle, *Engineering and Mining Journal*. December 19, 1914.

†T. A. Rickard, *Mining and Scientific Press*, March 20, 1909.

fornia.* The gravel was hydraulicked to a sump, where it was elevated by a bucket-ladder containing 52 7-ft. buckets to a trommel, where it was screened. The under-size went to the riffles, the over-size to a belt-conveyor 570 ft. long. At the end of the conveyor two Bleichert tramways were constructed to provide a larger dumping-ground for the tailing. This plant proved a failure, due largely to the unusually cemented character of the gravel and the complicated nature of the machine.

Steam-Shovels.—Where insufficient water renders hydraulicking impracticable and where the gravel is more or less cemented, attempts to work the ground with steam-shovels have been frequent, but, as far as we know, they have invariably failed.

As a digging machine, the steam-shovel is undoubtedly efficient, and its failure in gravel mining is due to lack of mobility and to the fact that its action is intermittent; that is, it dumps its load suddenly and the sluices are in consequence alternately over-burdened and over-flooded. This method of charging sluices is conducive to loss of fine gold. Difficulty has always been experienced in keeping the sluices up to the working-face. As far as transport is concerned, the shovel has all the disadvantages of the dredge in that its heavier parts are nearly as cumbersome as those of the latter. A 55-ton steam-shovel recently taken from the Panama Canal up the Magdalena river for mining purposes, furnishes a case in point. The size of its dipper is 2 cu. yd., the operating power 90 h.p. and the heaviest piece weighs 7 tons. It has a radius of 35 ft. and a lift of 12. In our opinion this attempt will end in failure, as no serious allowance has been made for the deposition of tailing, and the gold-saving devices are inefficient.

Drag-Scrapers.—So many improvements have recently been made in drag-line scrapers that they are now efficient digging machines in soft or loose ground. An example of the latest type of drag-line scraper is one now working at Cape Gerard, in Missouri, where it is digging a canal 200 ft. wide at the bottom and making a 20-ft. cut at a cost of 5 cents per cubic yard. Its radius is 125 ft. It is equipped with a 6 cu. yd. bucket and has a capacity of 4000 cu. yd. per 24 hours. The price of this machine was £7000.

FIG. 5. MECHANICAL ELEVATOR WITH SLUICE LEADING FROM THE DISCHARGE TO THE TAILING PILE, BEAUCEVILLE, CANADA. This sluice is lined with angle-iron riffles.

The disadvantages in the employment of these machines for gravel mining are the same as those attending the use of the steam-shovel: lack of mobility and intermittent action. And there is a difficulty in keeping the head of the sluices within the radius of the bucket.

It is our opinion that the drag-scraper has good scope in small areas of shallow loose gravel; deposits that would not warrant the erection of a small dredge. The drag-line is cheaper in first cost than a steam-shovel, it weighs less, is more easily erected, and has a wider radius of operation; but it will dig only loose ground or tailing, whereas the shovel will excavate cemented and heavy gravel.

Ground Sluicing.—There exist deposits where whole areas of rolling ground are covered with a thin film of gravel of varying depth,

* 'Present Day Problems in California Gold Dredging.' By Charles Janin. Transactions A.I.M.E., 1911.

which at times feathers out to bedrock, and upon which water can be brought but not under pressure. When the intervening gulches have sufficient grade for sluicing and disposal of the tailing, ground sluicing is the proper method. This method of mining has perhaps produced more of the world's gold than any other. In viewing the ancient Spanish workings in South American countries with their well designed ditches, one cannot fail to be impressed by the enormous amount of material that has been mined by this means.

The method consists of bringing the ditch to a point on the edge of the bank to be worked and allowing the water to cascade over the working face. The work of the water is assisted by the use of picks and shovels, and the larger boulders close to bedrock are worked around, if they cannot be moved. The duty of the water is, of course, low. For example, in a mine of this type in Colombia, 135 miner's inches running over a 5 to 15 foot bank gave a duty of only fifty cu. yd. per day.

Dry Placers. — In certain arid districts, notably Northern Mexico, Lower California, and parts of the States of California, Arizona and New Mexico, there are to be found deposits of so-called dry-placers. These are in most cases gravel, but sometimes detrital deposits occur. Economically, dry placers are not of great importance, but native miners, with small hand-blowing machines, often win a fair day's pay.

These deposits are usually shallow, more or less cemented by limonite, and their gold contents unevenly distributed, that is, they are patchy. Often they are of considerable extent. Serious attempts have been made of late years to work them on a large scale. Notably a group of claims in Southern California was recently offered in London. The claim was made that the gravel would average $1 per cu. yd. However, on examining carefully the method of sampling, it was noticed that the samples were taken mostly from gravel exposed in gullies and waterways leading down from an escarpment. In sampling any alluvial, exposed faces like these must, of course, be avoided; as there is in them a concentration due to the rains, and gravel taken from them is in consequence not representative of the deposit. In the case mentioned the sampler had salted himself.

The most serious attempt to work deposits of late has been by means of what is known as the Stebbins-Quinner machine, made in Los Angeles, California. After being dug by a steam-shovel the gravel, usually cemented, is pulverized and screened by the machine and the fine elevated and run over the Stebbins tables, which use air as a medium of concentration instead of water. Exclusive of the digging machinery, a plant, which it is claimed will treat 300 to 400 tons per day of 9 hours, costs $12,000. We have yet to learn that any of these machines using air as a means of concentration has proved successful. Laboratory tests of 300 or 400 lb. of gravel show encouraging results; but it is found in practice that the so-called dry material is never absolutely dry, but contains enough moisture to agglomerate, or 'ball' on the canvas, thus interfering with or preventing concentration.

Drift Mining.—Gravel that is covered by flows of igneous rock, or by a heavy deposit of overburden, and the metal in which is concentrated within narrow strata or streaks, is usually mined by drifting. The relative importance of the factors that govern the choice of this form of mining is often dependent on the conditions under which operation must be undertaken. For instance, in the early days of Californian mining, many deposits were drifted for their richer streaks by miners with little or no capital. Later, these deposits were hydraulicked with great success. In the same way most of the Oroville ground had been drifted before the advent of the dredge.

The proper conditions for the operations of a drift mine may be stated as follows: Rich concentrated gravel, without too large boulders, too much water or running sandy ground; availability of cheap timber and water for sluicing; bedrock that should not be 'swelling'; fairly loose gravel without cement; availability of skilled miners and timbermen. Long cross-cut tunnels or adits or deep shafts are necessary. They add greatly to the cost of opening the mine. A heavy flow of water necessitating much pumping is also a source of expense. Running sandy ground requires closer timbering and extreme vigilance. Nests of large boulders bring up the cost of mining, as they must be blasted.

Where the deposit is buried under a lava-flow, drift-mining is imperative. Where the rich streak is buried under a deep overburden of barren material the method is often advisable. In the case of frozen ground, as in Alaska, drift-mining has been almost universally employed in the smaller holdings. During the winter the gravel is taken out and piled on the dump, to be sluiced later with the spring thaw. Steam batteries with points are employed, and the necessity of timbering is obviated by the frozen nature of the ground.

LATENT ERRORS IN MINE-SAMPLING.

Discrepancies in results. Admixture of waste. Friable Sulphides. Patches of rich stuff.

By MORTON WEBBER.

IN basing a mine report on expected output upon sampled areas it should be understood by all concerned that an estimate founded on sampling will remain still an estimate. Irrespective of the experience and care exhibited in the work, the valuing engineer will undertake too much if he assumes that such data embody a statement of fact. The fallibility of an approximation cannot be eliminated although in cases it may be modified to meet the necessities of practical requirements.

There is a latent error varying with the mineral nature of the ore-structure that it is impossible under practical conditions to control by extreme uniformity in cutting samples and their close adjacency to each other. This error usually indicates a higher metallic content than shown throughout an adequate period of actual ore-treatment, affording data of results in mill-yield, plus residual contents. In the South African banket, the mill-yield plus tailing-content is from 6% to 15% short of the average indicated by sampling. In the premier lead mines of Australia the discrepancy is at least 10%. The results from four well known gold mines show an unaccounted difference of 12%. These mines are situate respectively in Mexico, Colorado, Australia, and India.

In the valuation of a mine conditions will generally fall under one or more of five classes. After tabulating these as below I shall endeavour to discuss each in turn. Under practical conditions many of these classes will merge and shade into each other in the same mine ; and they are separated here largely to facilitate explanation.

(1) Mines where the average metal-value is mechanically reduced, but where the unaccounted metal may be subsequently recovered.

(2) Mines where there exists an unrecoverable loss.

(3) Mines where sampling indicates a fictitiously high value.

(4) Mines were sampling results in an incorrect subnormal value, conclusive proof being afforded by subsequent commercial results.

(5) Mines where sampling is of no use.*

(1) In narrow veins where the breaking of waste is necessary, the ore going to the mill will be reduced in grade. Even if sorting is carefully done, it is impossible to keep all the waste out of the mill, especially if the enclosing walls are soft, yielding more or less fine. In a narrow vein it is customary to allow for this, but my experience is that such an allowance is generally insufficient. In veins of even normal width it is usually impossible to break ore without the inclusion of some waste. In such a case the discrepancy in metallic content may be considerable, owing to the fact that no hand-sorting may be employed. This discrepancy will largely adjust itself when the mine or stope is worked out as the decreased value per ton is compensated by the greater tonnage crushed. But the valuing engineer will, if he is wise, when computing his factor of loss, largely disregard this; as it will be difficult to explain to those not versed in valuation that the mill discrepancy will adjust itself at some future date.

(2) In mines where filling is necessary, and also in cases of underground sorting, there is always a loss in the waste, even where boarding is used. This may be a tonnage loss rather than of value per ton. Possibly a combination of both. In either case it is a loss of marketable contents that the mine-valuer should be careful to deduct from his estimate.

(3) Where the metallic contents of ores are in sulphide form the sulphides are frequently more friable than the gangue. In consequence, the samples will contain an abnormal proportion of high-grade 'metallics.' Discrepancies of this class are more usual in copper and other base-metal mines, but in the case of gold and silver ores, where the metal is enclosed in a vehicle of friable sulphide, this error should be very carefully considered, as it may result in an estimation out of all proportion to subsequent results.

(4) Where there are two sulphides in the same ore, one hard and dense and the other soft and friable, the latter will break more easily in sampling, and will therefore be ab-

* Credit should be given the *Mining and Scientific Press* for an article by the author on this subject, in June 1911.

normally represented in the valuation. If the major richness is in the hard sulphide the inference is liable to be unfair to the property.

Some years ago I examined a copper mine where the ore was chalcopyrite. After carefully sampling the ore exposed, which I estimated as a mass 550 ft. long by 8 ft. wide, and 300 ft. deep, the bottom of the mine at that time, my average was 4½% copper. My estimate of tonnage from this area was 440 tons per horizontal foot. Since that time this ore has been stoped. The tonnage actually marketed from this area has aggregated in round figures 130,000 tons or 430 tons per horizontal foot. Such a close estimate of final result clearly proves that the mass that was removed for market was practically the same as estimated in my examination. It is evident that the inclusion of waste and remaining pillars did not in this case vitiate the comparison. The subsequent marketing of this area, a question of fact, has proved my estimate of 4½% copper to be about one half per cent. low; or an error of over 11% of the total copper-value. It is my opinion that the unavoidable breaking down of an excessive proportion of the friable ore of lower grade was responsible for this error. For this there is no preventive under practical conditions. It is only possible to remedy the discrepancy by the addition or subtraction of a factor as the outcome of experience. Discussing the distance between sample-cuts, so often the resort of engineers, in difficult cases to conserve accuracy, will have no bearing in the matter.

(5) There is a class of mine where the valuable minerals occur in bunches. Under such conditions no confidence can be placed in an assay map, even although an unusually close sampling interval may have been employed. A level on a certain horizon may pierce a certain number of enrichments which would be represented on the sampling record. Had the horizon of the level been, however, 30 feet higher or lower, the number of enrichments pierced in the latter case would be out of all proportion to the former. In a mine of this type an attempt to sample blocked-out ore would be absurd. The nature of the ore occurrence would demand a veritable network of levels and rises so adjacent to each other that all hope of a commercial undertaking would be obliterated by the development charge per ton. Innumerable cases exist where an assay-plan would show the majority of samples as unprofitable, yet, the commercial result has afforded conclusive proof to the contrary. This class is not composed only of precious-metal mines. The base-metal mines of Missouri and the copper mines of Lake Superior are analogous. The only method of reliable valuation in a deposit of this type would be based on authentic record of past yield, in combination with competently selected representative shipments of the remaining ore.

Study of the foregoing cases will indicate the great care that should be exercised by an engineer in forming an opinion on the accuracy of another engineer's examination. There are many instances where an engineer has attempted to check a former examination by re-sampling a number of cuts. I am aware of several cases in which an engineer has been employed to check the work of another, and because he could not check a selected number of sample-cuts he condemned the mine; and without reason cast bad repute on the careful work of a fellow engineer.

Number of Pit	Sampling by W. $	Sampling by X. $
1	11·25	15·50
2	8·56	10·75
3	15·75	12·15
4	15·52	14·25
5	9·25	5·25
6	26·50	17·20
7	5·30	10·80
8	26·20	30·83
9	18·40	25·25
10	15·30	18·15
11	30·28	25·50
12	35·50	25·18
13	50·00	45·12
14	18·23	23·18
15	20·25	18·75
16	13·16	15·50
17	12·76	18·20
18	8·18	10·50
19	20·50	18·00
20	5·15	7·75

Some time ago I was employed to report on a gold-silver mine. It had been examined not long previous to my arrival by another engineer acting on behalf of the vendor. It was necessary to sample the floor of part of the lowest level for a distance of 200 ft. The ore had been stoped above. There was about 18 inches of broken decomposed material in the level bottom. The former engineer had sunk pits about 2 ft. deep, at intervals of every 10 ft. As the blasting and cutting of a fresh series of pits would entail considerable time, I decided to re-sample the old pits, after carefully cleaning and blasting a new surface. In both cases we sampled over 5 ft., the width between timbers. I here give the results of our sampling. The former engineer's results I tabulate with mine, for each of the 20 pits. My results are marked *W* while those of the other man are marked *X*.

It is at once noticeable that in no instance are our results even reasonably close. The samples individually, at best, only demonstrate commercial ore. This is all they seem to have in common. In checking a few selected pits, our results would have indicated a wide discrepancy. This might have thrown discredit on the entire work of the former engineer. That we are both equally correct is indicated by the average of our total results, namely, $18·30 and $18·29. Both samplings were over a width of 5 feet. These are facts that cannot be overlooked. They prove that where sulphides are sampled detailed comparisons are unreliable. They demonstrate that a fundamental factor in the use of sample data is the law of average. They show that decreasing the interval and taking more samples is not the remedy. Had I sunk fresh pits at 5-ft. intervals and re-sampled my own work I am satisfied that the results would have jumped about just as much. Certainly the final result could not be closer. In checking and comparing the sampling of different engineers in the examining of the same mine the proper use of averaging as a method of comparison should be as far as possible confined to the comparing of underground *areas*. The comparison of samples, *each to each*, is evidently decidedly unimportant.

In my judgment in analogous cases, where it is impossible to get individual samples to check, there is a strong probability that there will be a considerable discrepancy between sampling results and subsequent mill-headings. Such has been my experience. In the case above, while it might seem that the other engineer and myself could be proud of our ability as mine-samplers, I really think that we only succeeded in arriving at the same error. The discrepancy between mine-sampling and mill-ore in this case would probably not have been less than 10 per cent.

An attempt to tabulate the percentage of error under the relative heads discussed and to apply the results in specific cases is impossible. In the examination of a mine the engineer must use his own judgment. What has been written is intended to enable him to arrive at a conclusion based on sound premises on given conditions. In most cases sampling will over-estimate commercial results. The amount of error will vary from 5 to 25%. In the majority of cases the error is about 12%. Examples giving subnormal results are in the minority, and before any addition is made to sample-returns these facts should be thoroughly understood.

LEACHING WITH AMMONIA

By J. D. AUDLEY SMITH.

THE treatment of low-grade copper ore and tailing by leaching methods is receiving increased attention nowadays. Most of these methods employ acid, but in one case, the re-treatment of Calumet and Hecla tailing, reclaimed from the lake, the ammonia process is to be used. According to the American technical papers, the Calumet and Hecla management has decided to erect a 4000-ton plant under the direction of Mr. C. H. Benedict. No doubt the details of construction and operation have been decided after exhaustive tests. It is well known that the losses of solvent, which would be incurred without 'ammonia-tight' apparatus have been prohibitive in previous attempts. Mr. S. E. Bretherton has recently obtained a United States patent for a closed apparatus of special design, although the results of his experiments are not known.

It is interesting to record that the Arizona Copper company, which erected and started its acid-leaching plant in 1893, had previously conducted an exhaustive series of laboratory tests on the ammonia treatment. I was in charge of this experimental work, and afterward was associated with the acid-leaching project. I fortunately have preserved most of my notes, and am able to summarize the results that led to the abandonment of ammonia as the solvent. As the Magazine has always encouraged the publication of inconclusive or unfavourable results, I take courage to send you the following records:

The work was done in 1892. With the ordinary glass apparatus of the laboratory, it was found that about 96% of the ammonia employed could be recovered if absorbed in dilute sulphuric acid. The source of this loss of 4% was due mainly to atmospheric absorption and constituted a cost too great to be considered. The material forming the basis of the experiment was the Metcalf carbonate tailing, afterward successfully treated by acid, and the Longfellow carbonate tailing, which contained too much iron, alumina, manganese, and lime to be suitable for leaching by acids.

The analysis show the composition at that time. It is necessary to say that the copper assay-value diminished to less than 3% within a year after acid leaching was established. The present content, I understand, varies between 2·0 and 2·6 per cent.

	Metcalf Tailing. %	Longfellow Tailing. %
Insoluble	81·50	54·50
CuO	6·28	4·52
	(Cu = 5·01)	(Cu = 3·61)
Fe_2O_3	5·52	13·67
Al_2O_3 } Soluble in	1·68	7·33
Mn O } acid	Trace	4·83
Ca O	1·60	6·50
Mg O	Trace	3·12
SO_3	0·75	—

The extraction of copper by ammonia was rapid in the case of Metcalf tailing, and in 2 hours over 65% was dissolved. The addition of ammonium sulphate to the mixture increased the solubility to over 70% of the copper present, in the same time. Longfellow tailing gave up its copper much more sluggishly, and it was thought that the presence of sulphuric acid in the combined state in the Metcalf ore was responsible for the more vigorous solvent action, caused by the ammonia.

At this time, it seemed feasible to get better recoveries of the ammonia reagent by ammonia-tight apparatus, and in this connection experiments were instituted to determine the chemical action of the resultant liquors upon steel. The summary of this investigation is represented by the following experiments:

(1). Action of ammonia-copper liquors on chemically pure iron wire.

(*a*) 5 grammes of pure iron wire was covered in a test tube with liquor resulting from the leaching of Longfellow tailing with dilute ammonia (3·36% NH_3) for 48 hours. No apparent action was visible, and the iron wire, after washing and drying, still weighed exactly 5 grammes.

(*b*) 5 grammes of pure iron wire was similarly treated for 48 hours with liquor resulting from the leaching of Metcalf tailing with dilute ammonia containing ammonium sulphate in the proportion of 10% of salt to the weight of tailing treated. No action was noticed and the iron wire weighed as much after as before the experiment.

(*c*) The same 5 grammes of iron wire in the same solution was heated in a closed glass flask until the ammonia was distilled and recovered. The wire was much corroded, and after washing and drying carefully, had lost 41 milligrammes or roughly 0·8% of its weight.

(2). Action of ammonia-copper liquors on soft steel plate.

(*d*) A piece of steel plate, weighing 6·633 grammes, was placed in the distillation flask with solution obtained by leaching Longfellow tailing in dilute ammonia solution (3·36% NH_3). No visible action was discovered, nor any loss of weight.

(*e*) The same experiment was performed with a solution from treating Metcalf tailing in the same dilute ammonia water. The piece of steel was found to be coated with a thin film of copper, which was easily seen when rubbing with the finger. Loss in weight was equivalent to 0·23 per cent.

(*f*) Another piece of steel, weighing 7·734 grammes, was treated in the same manner while distilling and recovering the ammonia from a solution which had been used for leaching Metcalf tailing with 10% of its weight of ammonium sulphate, and the loss in this case was 0·23 per cent.

(*g*) The above experiment was repeated with a leaching solution from Longfellow tailing and 10% ammonium sulphate dissolved in the ammonia solution; the piece of steel lost 0·15% and showed similar signs of corrosion.

The deductions to be made from the above experiments were that while solutions free from soluble sulphates can apparently be distilled in steel vessels, this material is unsuitable for the construction of plant for this process when the ore is sulphide and has to be roasted. A preliminary wash with water would certainly remove soluble salts, but any insoluble basic sulphates still remaining in the product to be leached would probably be dissolved by the ammonia solution, and would attack steel or iron.

The above investigation was not continued, as the summer climate of Arizona was not favourable to ammonia recovery, and promising results were being obtained in the laboratory using sulphuric acid as the solvent.

Mass Copper.—In the early days at Lake Superior, enormous masses of native copper were found on the surface, and subsequently similar masses have been found underground. A correspondent in the *Mining Press*, in the issue of January 9, states that a mass has been found recently at the Trimountain mine, belonging to the Copper Range Consolidated group, that promises to yield several thousand tons. It was first discovered at a point 50 ft. above the 25th level, and it has been traced, so far, for 300 ft. down to the 27th level. On the latter level there is no indication of the mass coming to an end. Its average width is 40 ft., and it is from 6 to 8 in. thick. Two men are continually at work on it, cutting it with air-driven chisels. Similar masses were found at the Calumet & Hecla and the Ahmeek mines. That found at the Calumet & Hecla extended for 800 ft. on the dip; and that at the Ahmeek from surface to the 16th level.

DISCUSSION

Tasmanian Nickel Deposits.

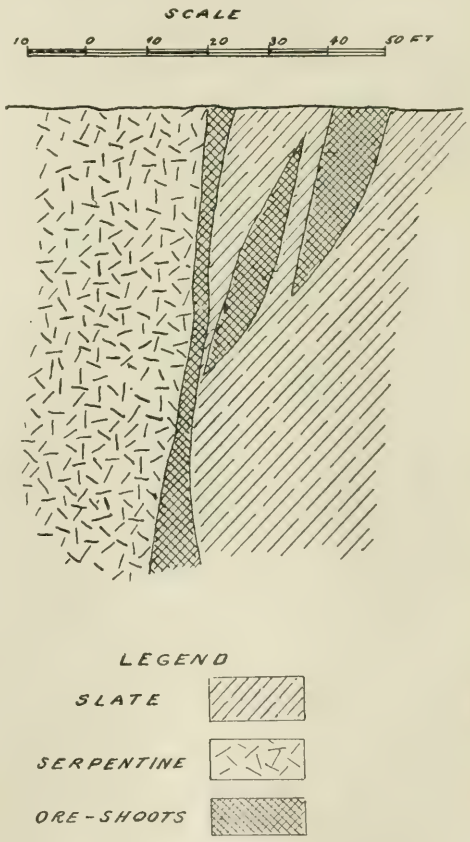
The Editor:

Sir—The occurrence of nickel in Tasmania was mentioned in the *Engineering and Mining Journal*, Vol. 78, 1906, and briefly by Dr. A. P. Coleman in his monograph entitled 'The Nickel Industry,' published in 1913; but not much was known concerning the nature of the deposits, and little had been done in their exploration and development until recently.

The two principal known occurrences of the metal are in the west of the island, one of which is in the Dundas mining district near Zeehan, and the other on the west coast at Trial bay, 14 miles away. During the past three or four years considerable development work has been done on the Dundas deposit, where four separate ore-shoots of high-grade copper-nickel ore have been found on a line of contact between serpentine and slate rocks extending for about a mile north and south. Two of the ore-shoots have been recently worked by private companies, which acquired adjoining properties. One so far has yielded highly satisfactory results financially, and the other may do so later.

The deposits occur in the slate near its contact with the serpentine, as shown on the cross-section through one of the deposits developed. It will be seen that the irregular lenticular masses of ore that are farthest from the serpentine have pinched-out at shallow depths, while the ore-shoot nearest the contact with the serpentine continues downward from the surface so far as exposed, and has more the aspect of a contact-fissure deposit, which it may prove to be on further development.

The ore-shoots are principally composed of sulphides of iron, nickel, and copper, or nickeliferous pyrrhotite, and contain from 8 to 12% Ni and 4 to 6% Cu; lower-grade ore also occurs at a depth of 70 ft. in a portion of the lode nearest the serpentine, the face of the drift on it showing at one place 6½ ft. of ore, 4 ft. of which assayed 8·26% Ni and 4·2% Cu, the remaining 2½ ft. assaying 1·17% Ni and 1·80% Cu. Secondary enrichment is evidenced by the richer ore being found nearest the surface and by the ore becoming harder and more silicious with depth. The following assay of a 100-ton lot shows approximately the average contents of such ore as has been mined and shipped up to date: Ni 9·61%, Cu 4·7%, Fe



Section at Dundas Nickel Deposit.

32·8%, S 32·66%, SiO_2 5·24%. Some silver and platinum are present, as indicated by an assay for precious metals made by Daniel C. Griffith & Co., of London, who reported Ag 2·2 oz. per ton, Au trace, Pt 0·06 oz. per ton.

The association of nickel with serpentine is well known, and it has been proved to be one

of the chief sources of the metal, though the ore deposits derived from it may be either of a secondary nature, resulting from erosion of the parent rock, or be primary deposits of magmatic origin. In the present instance the serpentine near the surface contains no traces of disseminated ore, as far as is known, yet it is quite admissible as the origin of the sulphide ore-shoots under notice, which are recognizable as contact-fissure deposits formed through the agency of ascending thermal solutions, subsequently enriched by erosion and descending surface water. It does not, however, follow that these ore-shoots, even if originating from a deep-seated source, will prove of great persistence in depth ; other factors, known to students of ore deposition, require due consideration, and in the present case point to an early impoverishment with depth.

The Dundas deposits, although of unusually high grade, are of relatively small dimensions, the longest shoot of ore in any instance not exceeding 150 ft., with an average width of 4 to 5 ft. ; so that richness and size are here exemplified in inverse ratio. Nevertheless, it has already been found, in one instance at least, that these deposits are workable at considerable profit, and were it not for the wet nature of the country and heavy influx of water into the mines, they would be veritable bonanzas in a small way.

Another drawback is the heavy cost of transporting the metal in the form of crude ore to European smelters. This could, however, be obviated by smelting and converting the ore to a matte of about 80% metal before shipment, with the additional advantage of securing a higher price per unit of nickel and copper in the matte than is obtainable for the same in crude ore, and of being enabled to deal profitably with the lower-grade ore, which, under present conditions, must be left in the mine. Though technically the above advantages are apparent, other considerations of an economic nature are the real determining factors, and these are not yet solved.

At Trial Bay on the west coast, little exploration or development work has been done as yet. Within a short distance of the shore a hill of nickeliferous serpentine rises to a height of over 300 ft., and extends inland for some distance. Three adits, each about 100 ft. long, have been driven into the hill from different points of the compass. These adits have been sampled throughout their length, and samples have also been taken of the rock on the surface ; the assays of the samples range from 0·34 to 0·83% Ni, their average being 0·51%. The ore in the serpentine is said to be niccolite (NiAs), and to be disseminated in grains visible to the naked eye. In one of the adits a vein of high-grade ore consisting of garnierite, was intersected ; this was sampled across a width of 12 in. and assayed 13·35% Ni. The place of origin of the garnierite deposited in the vein is seen to be the enclosing rock that is impregnated with nickel, the garnierite being a secondary deposit of hydrous silicate of the metal, resulting from denudation of the serpentine and sub-aerial agencies.

The Trial Bay formation can be compared to that of New Caledonia, which is marked by the presence of nickeliferous peridotite changed into serpentine, and the occurrence of silicate of nickel as a secondary mineral. On the other hand, the Trial Bay nickel deposit bears no resemblance to that at Dundas, either in form or origin, though they both hold a common relationship to the serpentine, which is in one case impregnated with the metal, while in the other it does not appear to be so. It is worth noting that the sampling of one of the Trial Bay adits in the serpentine gave an assay of 0·83% Ni, and that the niccolite ore in the hill is amenable to water-concentration. Whether any portion of the metalliferous serpentine hill could be worked profitably as a low-grade proposition remains to be demonstrated. The garnierite deposits offer an additional inducement to further exploration of what may prove to be the most important occurrence of nickel in Tasmania. As regards local conditions, the Trial Bay deposit is without railway connection to any other place in the island, and in the matter of transport of ore to Europe, would be in a worse position than Dundas, as Trial bay is a shallow open roadstead, so that all ore would need to be loaded into coasting vessels and taken to the ports of Strahan or Burnie for shipment to Europe by way of Melbourne or Sydney. The same observations on the reduction of the Dundas sulphide ore to a matte before shipment apply equally in the case of the silicious garnierite at Trial Bay ; an admixture of the two ores would be advantageous in the smelting of either, and reduce actual smelting costs. The drawback of heavy pumping charges would not obtain at Trial Bay, for adits driven into the hill would take the place of shafts, as at Dundas, at least for years to come.

The production of nickel in Tasmania, though still of relatively small importance, is not without such future possibilities as to invite due attention. I am indebted to the Dundas Cuni

Mining Company for most of the above information, and not having personally examined either of the occurrences above mentioned, I am aware of certain unavoidable disabilities in describing them.

A. G. WHITE.

London, December 5, 1914.

The New Rand.

The Editor:

Sir—With reference to the comments by your Johannesburg correspondent on the New Rand in your issue of January, I shall be obliged if you will allow me to make the following remarks.

The only other parts in the Orange Free State in which a search for the Main Reef has been made by means of bore-holes are situated in the Venterskroon goldfield. This goldfield encircles the Vredefort granite mass, with Vredefort as a centre. The northern segment of this annular formation lies in the Transvaal, and the southern segment is hidden by Karroo beds, leaving only the eastern and western segments exposed in the Orange Free State. The prevailing high inclination of its strata militates against prospecting with vertical bore-holes. The complicated geological conditions account for differences of opinion in the past as to the locality of the Main Reef.

It may not be generally known that the Government Geological Survey of the Witwatersrand System started with the Venterskroon goldfield by the advice of Dr. E. T. Mellor who, however, after a time came to the conclusion that he could not make any progress, owing to the geological conditions prevailing there, until he had first mapped the Witwatersrand area itself. The survey of the Venterskroon goldfield is still in abeyance.

It cannot be argued from the fact that igneous flows were encountered in the Venterskroon goldfield "at the exact spot where on geological grounds the Main Reef might be looked for" in one or two instances that the reefs are there non-existent, as your correspondent seems to imply.

It is common knowledge that igneous intrusions between the planes of stratification raise the overlying strata, thereby displacing them. In view of the fact that the strata are known to vary in thickness on the Rand, and considering the possibility of faulting, how can anyone venture to fix on any *exact* spot for the finding of a conglomerate bed such as the Main Reef? Igneous intrusions in the vicinity of the Main Reef occur frequently on the Rand.

The search for the Main Reef in a new area, especially beneath younger strata, requires systematic and persistent effort. To stop boring, where prospecting by bore-holes was justified at all, because one or two bore-holes have given negative results is, in my opinion, inconsistent. It may incidentally tend to unduly affect a whole district.

As the New Rand area is equidistant from the Rand and Vredefort, namely 50 miles from each, it is as logical to anticipate that results in that area will be as satisfactory as on the Rand, especially as the inclination of the strata is the same in both and the sequence of their strata so far corresponds, as to anticipate unsatisfactory results, such as have attended the search for the Main Reef in some parts of the Venterskroon goldfield.

In any case, those who control and support the New Rand venture are satisfied, from the results so far obtained, that their search for the Main Reef is much more likely to be attended with success than not.

A. R. SAWYER.

London, January 18.

Prospecting for Alluvial Tin.

The Editor:

Sir—In your January issue, Mr. G. Stewart Paterson writes interestingly on the subject of 'Prospecting for Alluvial Tin in Nigeria.' I take exception to the method described for determining the value of the gravel by means of Banka or Empire drills. From the statements on pages 39 and 40, it is clear that the method of keeping the hole in advance of the casing has been employed. This is precisely what should not be done, and great pains should be taken by the man in charge to see that the hole is never in advance of the cutting-shoe. With both these drills, the ground within the casing is removed, by means of a sand-pump, as a sample, and if the sand-pump is allowed to work below the casing, there is nothing to prevent an excess of ground being removed, thus procuring an inaccurate sample. As a check, it is usual to measure the material recovered from the bore-hole, and should it exceed the amount expected, the result should be viewed with suspicion. In my opinion, if it is proved that the tools have worked in advance of the cutting-shoe, no reliance can be placed on results from such holes.

Drillers are inclined to keep the tools ahead of the cutting-shoe, for by this means drilling is easier and quicker, and this procedure is correct when it is not desired to obtain an accurate sample of the ground through which

the bore-hole passes. Sometimes, as with foundations, the depth only is required, and then, in the language of the lawyer, speed is the essence of the contract.

JAMES T. DIXON.

Sutton, Surrey, January 18.

Naturalization.

The Editor:

Sir—In the article on Naturalization in your January number you state that you are not aware of any official confirmation of the statement that a German subject loses his nationality *de facto* the moment he takes the oath of allegiance to another country. A case that has come to my knowledge may interest you in this connection. A German, who took out a certificate of naturalization in London in 1907, went back to Germany two years ago last August, and was residing in that country when the war broke out. A few weeks ago I heard from a relative of his that he had been interned with many British-born subjects in the German concentration camp at Ruhleben.

J. L. GALLARD.

London, January 18.

Lead and Zinc from Broken Hill.

The Editor:

Sir—Referring to the information in your October number about Broken Hill outputs of lead and zinc concentrates, will you allow me to correct the figures as follows:

In 1913 a total of 312,156 tons of lead concentrate was made, of which only 103,428 went to the Port Pirie and Cockle Creek smelters in Australia, leaving 208,728 tons for export to Europe. Of zinc concentrate in 1913, 404,962 tons was made, of which only about 12,000 tons was treated at Port Pirie, leaving roundly 393,000 tons for export. The error may have crept into your figures owing to the fact that at the year-end there are always some stocks of concentrate left at Broken Hill or Port Pirie—a small amount of lead concentrate, but at times over 100,000 tons zinc concentrate. Being in the business of exporting these concentrates to Liége, I have occasion to keep the weekly records of each Broken Hill mine. Today, the North and South mines are sending about 5000 tons of lead concentrate monthly to Port Pirie, where it is smelted with about 2500 tons monthly of Broken Hill Proprietary lead concentrate. Part of the lead bullion produced is being refined and exported to the east of England as soft lead, the rest in the form of lead bullion is held at Port Pirie waiting a sale to some of the English desilverizing works. Of the other Broken Hill producers, the South Blocks and Zinc Corporation have stopped production pending the arrangements mentioned in your Magazine, while the Central continues in nearly full activity, sending its lead concentrate to the Cockle Creek works and exporting the lead bullion to London. Zinc tailing which would ordinarily be sent to the flotation plant is being stacked at the mines. This state of affairs means the closure of the Broken Hill mines within the next six months, unless an outlet can be found for the zinc concentrate. It is not realized perhaps how important the by-products of zinc concentrate and also of flotation lead concentrate made in the de-leading of the zinc concentrate have become during the last year or so. Taking an average concentrate of 65% lead, 25 oz. silver, with lead at £18 and silver at 2s. 6d., the gross value would be about £15, while the average cost of making 1 ton of lead concentrate at 8 producing mines plus a returning charge at £5, is about £13, leaving a bare £2 to meet other costs. The value of the by-products of zinc tailing, slime, and middling, which gave formerly zinc concentrate and flotation lead concentrate, was £4 per ton. If this £4 is now cut off, it leaves a very narrow margin of profit.

ROBERT SLESSOR.

Sydney, N.S.W., December 1, 1914.

The Metal Trade.

The Editor:

Sir—Referring to Mr. Louis E. Horne's letter in the January issue of the Magazine, may I be permitted to point out that there are two or three smelters in England at the present time that can deal with, at any rate, two of the most valuable of the ores mentioned, namely those of molybdenum and tungsten. Over 1000 tons per year of wolfram and scheelite can be converted into ferro-tungsten in England at the present time, and I believe all the molybdenite Australia produces can be smelted into ferro-molybdenum.

The works are well known to the leading firms of mineral and metal brokers here; and before long larger quantities of tungsten ores will be treated in Britain for the production of tungsten as well as its ferro-alloy.

There is the greatest demand for high-grade wolfram ore with low tin content, and some of the Australian concentrate is the best in this respect.

BENEDICT KITTO.

London, January 20.

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.*
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	Jan. 4* 1915	Feb. 1† 1915
RAND:			
Bantjes	14	—	10
Brakpan	51	59	49
Central Mining (£12)	160	120	120
Cinderella	6	5	3
City & Suburban (£4)	52	47	49
City Deep	66	57	59
Consolidated Gold Fields	43	29	27
Consolidated Langlaagte	35	34	34
Consolidated Main Reef	18	18	19
Crown Mines (10s.)	120	91	79
Durban Roodepoort	21	20	20
D. Roodepoort Deep	17	17	16
East Rand Proprietary	33	29	29
Ferreira Deep	47	40	45
Geduld	23	20	21
Geldenhuis Deep	26	21	23
Heriot	55	52	55
Jupiter	5	40	3
Kleinfontein	24	19	19
Knight Central	8	6	5
Knight's Deep	35	25	25
Langlaagte Estates	20	17	18
Luipaard's Vlei	10	9	9
Main Reef West	7	5	6
Meyer & Charlton	115	102	106
Modderfontein B	89	85	91
Modderfontein, New (£4)	263	249	260
Nourse	27	25	25
Primrose	21	16	17
Rand Mines (5s.)	120	98	92
Randfontein Central	17	14	14
Robinson (£5)	57	40	41
Robinson Deep	33	26	24
Rose Deep	43	39	39
Simmer & Jack	12	14	9
Simmer Deep	1	1	1
Springs	11	13	16
Van Ryn	67	62	59
Van Ryn Deep	47	46	47
Village Deep	40	37	37
Village Main Reef	40	31	35
Witwatersrand (Knight's)	71	64	64
Witwatersrand Deep	48	41	39
Wolhuter	14	11	12
RHODESIA:			
Cam & Motor	19	15	16
Chartered	17	12	12
Eileen Alannah	11	7	9
Eldorado	18	14	14
Enterprise	9	5	6
Falcon	14	12	13
Giant	14	9	9
Globe & Phœnix (5s.)	32	32	32
Lonely Reef	27	24	25
Shamva	46	41	35
Wanderer (5s.)	3	—	2
Willoughby's (10s.)	7	6	6
OTHERS IN SOUTH AFRICA:			
De Beers (£2 10s.)	330	187	195
Glynn's Lydenburg	11	10	12
Jagersfontein	78	60	55
Premier Diamond (2s. 6d.)	152	82	75
Sheba (5s.)	4	4	3
Transvaal Gold Mining Estates	37	39	39
WEST AFRICA:			
Abbontiakoon (10s.)	8	9	9
Abosso	14	10	9
Ashanti (4s.)	16	14	15
Broomassie (10s.)	2	2	2
Prestea Block A	15	11	12
Taquah	15	14	14
WEST AUSTRALIA:			
Associated Gold Mines	7	5	5
Associated Northern Blocks	7	7	5
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	54	50
Great Boulder Proprietary (2s.)	14	14	15
Great Boulder Perseverance	2	2	2
Great Fingall	9	5	5
Ivanhoe (£5)	50	47	46
Kalgurli	36	37	34
Sons of Gwalia	23	20	21
Yuanmi	3	3	2

	July 1 1914	Jan.4* 1915	Feb. 1† 1915
OTHERS IN AUSTRALASIA:			
Blackwater	16	—	15
Consolidated Gold Fields of N.Z.	13	—	11
Mount Boppy	10	11	11
Mount Morgan	52	41	46
Progress	10	—	7
Talisman	33	27	29
Waihi	42	37	39
Waihi Grand Junction	25	24	26
AMERICA:			
Alaska Treadwell (£5)	162	160	152
Buena Tierra	15	—	15
Butters Salvador	20	10	10
Camp Bird	9	6	8
Canadian Mining	—	7	9
Casey Cobalt	13	5	7
El Oro	14	10	10
Esperanza	15	9	9
Granville	10	—	—
Kirkland Lake Proprietary	74	35	34
Mexico Mines of El Oro	97	80	86
Oroville Dredging	10	10	12
St. John del Rey	15	14	15
Santa Gertrudis	11	9	11
Tomboy	22	22	24
Tough-Oakes	28	12	14
RUSSIA:			
Lena Goldfields	43	24	29
Orsk Priority	7	—	—
Siberian Proprietary	3	—	—
INDIA:			
Champion Reef (2s. 6d.)	11	12	11
Mysore (10s.)	93	86	86
Nundydroog (10s.)	27	24	25
Ooregum (10s.)	23	22	24
COPPER:			
Anaconda (£5)	126	105	111
Arizona (5s.)	36	—	—
Cape Copper (£2)	60	50	50
Chillagoe (10s.)	1	⅜	¼
Cordoba (5s.)	6	4	3
Great Cobar (£5)	3	4	4
Great Fitzroy (5s.)	½	½	½
Hampden Cloncurry	27	18	21
Kyshtim	55	39	45
Messina (5s.)	15	12	12
Mount Elliott (£5)	55	67	71
Mount Lyell	23	21	23
Rio Tinto (£5)	1355	1155	1150
Sissert	25	21	21
South American Copper (2s.)	22	14	12
Spasskv	52	40	41
Tanalyk	78	44	47
Tanganyika	40	29	28
Tharsis (£2)	125		—
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	28	16	18
British Broken Hill	36	21	21
Broken Hill Proprietary (8s.)	36	31	33
Broken Hill Block 10 (£10)	32	25	22
Broken Hill Block 14 (25s.)	6	—	—
Broken Hill North	52	40	39
Broken Hill South	175	120	117
Sulphide Corporation (15s.)	26	16	16
Zinc Corporation (10s.)	19	12	11
ASIA:			
Burma Corporation	28	30	30
Russian Mining	31	10	20
Russo-Asiatic	151	84	80
TIN:			
NIGERIA:			
Bisichi	8	7	7
Jos (5s.)	5	5	5
Kaduna (5s.)	15	15	15
Naraguta	17	16	17
N. Nigeria Bauchi (10s.)	3	1	1
Rayfield	5	3	4
Ropp	100	19‡	19‡
OTHER COUNTRIES:			
Aramayo Francke	31	22	25
Briseis	5	5	5
Cornwall Tailings	17	—	10
Dolcoath	11	11	9
Geevor (10s.)	5	2	2
Gopeng	27	24	26
Mawchi	20	4	1
Pahang Consolidated (5s.)	7	5	6
Renong Dredging	36	22	24
Tekka	55	55	57
Tronoh	26	25	26

* Date of re-opening of Stock Exchange; the nature of the transactions being within strict official limitations.
† Conditions still restricted. ‡ Denomination of shares recently changed form £1 to 4s.

PRECIS OF TECHNOLOGY

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.]

Magmatic Waters.—At the meeting of the New York section of the Mining and Metallurgical Society of America, held on November 19, James F. Kemp gave an address on recent investigations and theories relating to the existence of magmatic waters, and their action in forming ore deposits. Some of the recent discussions on this subject have been confined to strictly scientific circles, and have been overlooked by the ordinary practical geologist. Professor Kemp's address served to popularize recent investigations, and make them more generally known within the mining profession. It will be remembered that Posepny, in 1892, enunciated his theory of the formation of ore deposits from ascending solutions. His view was that the meteoric waters (that is rain-water) percolate downward through the rocks, dissolving small amounts of such metal as may be present, until they reach a hot zone. They then become heated and rise through crevices, in which they deposit their metal in the concentrated form known as an ore deposit. In 1900, C. R. Van Hise followed with a theory on much the same lines. On the other hand, J. H. L. Vogt, the Norwegian geologist, had written much on the function of water and gases evolved from magmas, establishing the theory of pneumatolysis and hydatogenesis. The Austrian geologist, Eduard Suess, in 1902, confirmed Vogt. While the two schools, relying on meteoric and magmatic origin respectively, were in full controversy, Mr. Kemp, T. A. Rickard, and J. W. Finch published evidence that the circulating groundwaters, on which the meteoric theory relies, do not go downward as far as the hot rocks or the igneous magmas, and that as a matter of fact the majority of deep mines are dry in their lowest levels. The Posepny school thus received a severe blow. A corresponding knock to the magmatic school was delivered by a Swiss chemist, Paul Brun, who in 1910 published his view that the existence of water in volcanic rock was a myth, basing his argument on the analysis of gases emitted by volcanoes visited by him. A. P. Day and E. S. Shepherd, of the Carnegie Geophysical Laboratory, of Washington, determined to investigate Brun's statements, and visited one of his volcanoes, Kilanea, in the Hawaii Islands. Here a lake of fire has existed in the crater for some time. During Messrs. Day and Shepherd's visit, a dome of solidified lava formed on the solid flat a short distance from the pool of molten rock. It was possible to approach this dome and to push an iron tube into a crevice. This tube was connected to glass condensation-reservoirs and a pump, and the gases emitted from the magma could be drawn into the reservoirs and cooled. By this means a considerable amount of water was obtained almost immediately. The investigations proved conclusively that magmatic waters do exist.

In 1905, Waldemar Lindgren and Professor Kemp were working independently on the theory of the origin of lime-iron garnet rock at contacts of impure limestone and igneous rocks, and they both came to the conclusion that emanations containing steam, iron salts, silica, etc., from the igneous rock reacting on the limestone produced the garnet. The older theory of simple contact and heat could not explain the introduction of iron, seeing that iron was not present in the limestone. Gaseous and water emanations carrying iron and silica from the igneous rock provided the only acceptable theory. Incidentally therefore the magmatic-water theory received confirmation.

In discussing the part played by meteoric waters in ore deposition, the opponents of the theory have always pointed out that it contains an apparent contradiction, for it supposes that solution and reprecipitation occur under practically identical conditions. Geologists commenced to study the constitution of descending waters to see what actually happened, and Edwin T. Hodge has recently shown in one particular case that descending rain-water becomes an acid solution of zinc, copper, and iron after passing through the gossan, and that these metals are subsequently reprecipitated at depth. Thus there would be no metal left to form an ore deposit if this circulating water rose again. In concluding his address, Professor Kemp summed-up in favour of magmatic waters, holding that the meteoric-water theory had lost ground.

Electrolytic Zinc.—In the *Mining Press* for January 2, E. H. Leslie gives particulars of the process introduced by Messrs. Reed and Leach for electrically precipitating zinc from sulphate solutions. The plant has been erected at Palo Alto, near the Mammoth smelter at Kennett, California, and it is treating fume recovered in the baghouse. This fume contains 38% zinc sulphate, 14% zinc oxide, with oxides and sulphides of iron, copper, lead, and arsenic, 1 dwt. gold and 11 oz. silver per ton, the remainder being chiefly silica. This fume has accumulated for years, and has been hitherto untreatable. The zinc, being largely in the form of sulphate, does not require much additional acid to be added to the leaching solution. The difficulty with all electrolytic precipitation processes is that the solutions become foul, the acid accumulates, and the zinc is reduced in spongy form. The inventors have modified a process, patented by Carl Hering, in which excess of acid is prevented by having anodes of spongy lead. The excess of SO_3 liberated in electrolysis at the anodes reacts on lead to form sulphate. Subsequently the anodes are removed to another bath where they are exposed to the action of a reverse current which removes the sulphuric acid. The zinc is precipitated as a thin crystalline sheet which can be melted. In this way the process has the advantage over older processes that produced a spongy zinc, which oxidized instead of melted on heating. Further experience with the new process is awaited with interest.

Chrome Ore in Rhodesia.—On September 7 last, A. E. V. Zealley read a paper before the Geological Society of South Africa, describing the geology of the chromite deposit at Selukwe, Rhodesia. Incidentally we may say that this deposit is worked by the Rhodesia Chromite Mines Limited, a company belonging to the Bechuanaland Exploration Co., of which Edmund Davis is chairman, other mines belonging to the same group being the Bwana M'Kubwa and the Rhodesian Broken Hill. The Chrome mine has been a producer since 1907 and in 1913 the output was about 60,000 tons The chromite is found in a talc-schist and serpentine rock, which forms an irregular narrow body widening at its northern end where the mine and the town of Selukwe are situated. The rock has intruded on the older formation to the east, which is composed of banded ironstone and conglomerate belonging to pre-Cambrian age, and in its turn has been invaded by the Mont D'Or granite. Ultra-acid granite intrusions are found in the wider part of the talc-schist rock and form the prominent hills of the neighbourhood. The constituent rocks of the talc-schist and serpentine group present a great variety; they are chiefly talcose,

carbonate or dolomitic, and chlorite schists, and serpentines are present only in small amount. The main types are grey and buff talc-schists, speckled talc-carbonate schist, red talcose and green chloritic schists, pale and dark green serpentines, and a quartz-chromite rock considered to be a silicified serpentine. The talc-carbonate schist and silicified serpentine are resistant to eroding agencies, the former giving rise to sharp

form of lenses. At the mines at Chrome Hill, the chromite is in whitish speckled talc-schist, which is not always pronouncedly schistose and usually fairly silicious, and also in ferruginous silicified serpentine. As a rule the chromite bodies are situated near the margin or on the actual edge of the talc-schist-serpentine formation, and occasionally they pass into the adjacent formations. Over 130 lenses have been mapped on the

crags at Black Rock, and the latter to rounded hills, as at Chrome Hill and Selukwe Peak. The serpentines appear to be chiefly metamorphosed peridotite. The silicified serpentines consist of massive chert, and are of green colour derived from chromium. In some places they have a schistose structure. Chromite is always present, and usually hematite and chlorite. Chromite is distributed throughout the talc-schists and serpentines in disseminated crystals and grains, but at certain places, notably in the talc-schist, talc-carbonate schist, and silicified serpentine, it occurs massive in the surface at various points, ranging from 150 to 450 ft. in length. Ten are at the Chrome mine, partly merging into each other, and being easily attacked by ordinary quarrying methods. Mr. Zealley enumerates nine other main occurrences of chromite. The positions of these are marked on the accompanying map.

Mr. Zealley discusses the origin of the chromite. He points out that occurrences in other parts of the world are in rocks less metamorphosed than those at Selukwe, so that the elucidation of their origin is more difficult, seeing that we cannot easily tell to what ex-

tent the chromite has been altered also. He considers, however, that there is no apparent reason to depart from the usual theory that the chromite is an original crystallization in the magma from which the talc-schists were derived. Further investigation is required, especially in the petrological laboratory. In discussing the field evidence, Mr. Zealley says that the chromite is confined to an irregularly shaped formation and is widely distributed throughout it, and that this association can hardly be accidental, but must be considered genetic. The mineral may represent matter differentiated and progressively segregated from the whole of a large complex to the particular rocks that gave rise to the talc and talc-carbonate schists and silicified serpentine. There is no evidence that the chromite lenses occupy openings caused by fracturing or fissuring, or any other structure favourable for ore-deposition.

Pyrite Smelting at Mount Lyell.—At the November meeting of the Boston section of the American Institute of Mining Engineers, Robert E. Sticht gave an address detailing the history of pyrite smelting at the Mount Lyell copper mine, Tasmania. A report of this address, with comment, was written by Professor E. D. Peters for the *Engineering and Mining Journal*, and appears in the issue of December 26. The Mount Lyell mine was examined by Dr. Peters in 1892-3, and he saw the particular applicability of the ore for the pyritic smelting method, whereby the heat of the sulphur is used for melting the charge. Coke was expensive, and the massive sulphide nature of the ore pointed to the advisability of this process being given a trial. Attempts had been made in America to adopt this principle, at Boulder in Montana, and Kokomo in Colorado, by Robert E. Sticht, and by T. S. Austin at Toston, Montana. Mr. Sticht has stated that he owed much to John Hollway's experiments in connection with bessemerizing pyrite and to Mr. Austin's work at Toston. Dr. Peters recommended Mr. Sticht's appointment to Mount Lyell, and the history of the treatment of these ores forms an important chapter in the records of metallurgy.

Mr. Sticht, on his arrival at the mine, determined to adopt pyritic smelting immediately. The furnace was run with what was considered at that time a large volume of air and with hot blast. It selected for itself, under these conditions, a slag that had a silicate degree of about 4 : 3 ; being thus somewhat more basic than bisilicate. As the main purpose of the Mount Lyell smelting operation was to flux the maximum quantity of iron with the minimum amount of barren silica, this slag was too silicious for the most economical work. The ratio of concentration was between 6 : 1 and 7 : 1, and the resulting matte contained below 25% of copper, thus requiring a second pyritic fusion to make it suitable for the converters. After careful study and experiment Mr. Sticht discarded the hot blast, heightened his ore column, doubled the volume of air, and at once brought his slag to the condition of a monosilicate, containing only about 30% silica. Over 90% of the iron in the charge was scorified at a single operation. The ratio of concentration established itself at about 20 : 1 ; and the grade of the matte rose to 40-45% copper. About 1% of coke was used. This scheme was continued unaltered until changing conditions demanded some modification of practice. The Mount Lyell pyrite has dropped to about 0·5% copper, but the grade of the furnace-mixture has been kept up to its normal standard of nearly 2·5% copper by substituting the 7% quartzose copper ore of the North Lyell mine for the barren silica formerly used. The low-grade massive pyrite ore of the old Mount Lyell mine thus plays the role of flux and fuel, while the profit is derived from the North Lyell ore. Owing to an increase of earthy constituents in the furnace mixture, the coke has been increased to about 3 per cent.

Mr. Sticht's work and investigations at Mount Lyell have enriched our practical knowledge of pyrite smelting by two important contributions : (1) That the increased furnace activity produced by an increased volume of air (with corresponding heightening of the ore column), rather than a heated blast, is the essential feature in bringing about the conditions necessary for the production of a more highly ferruginous slag, the slagging of the maximum amount of iron with the minimum amount of silica being the great desideratum in pyrite smelting. (2) That true pyrite smelting is a bessemerizing operation presenting little analogy to roasting ; that, in normal running, the process of oxidation, from the oxygen blast, occurs in a circumscribed area that extends only a comparatively short distance above the tuyeres ; and that, consequently, above this zone the gases contain free oxygen only in negligible quantity.

Prospective Oilfields of Western Canada.—At the February meeting of the Institution of Petroleum Technologists, E. H. Cunningham Craig read a paper describing the oil districts in Western Canada. We have during the last year or so made many references to these oilfields, but it is of interest to place on record the views expressed by one of the leading English petroleum experts. Practically all the oil so far discovered in Western Canada has its origin in Cretaceous rocks, though in some cases it is possible that Tertiary strata will be proved petroliferous. The Cretaceous formation varies greatly in thickness and lithological characteristics throughout the wide area, but it is possible as a rule to distinguish five main groups, three arenaceous and littoral, and two argillaceous and marine or estuarine. The formation has been divided as follows :

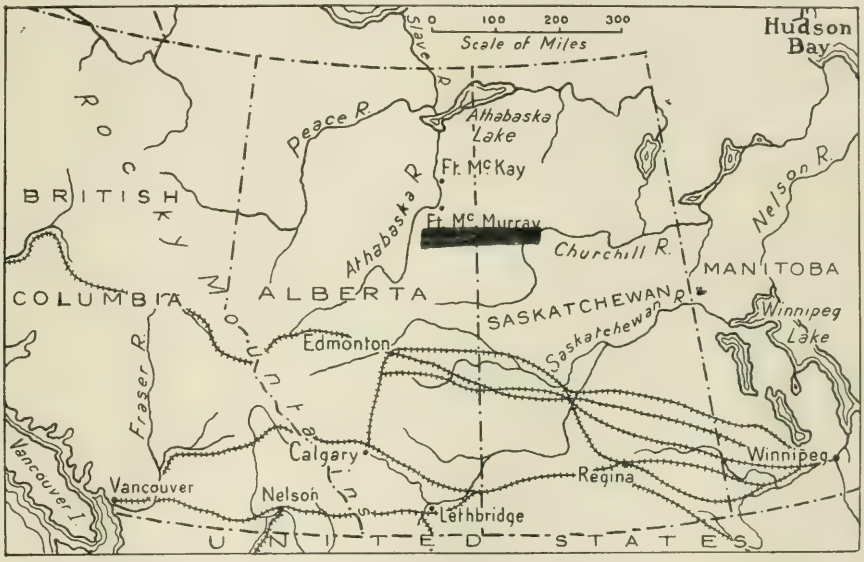
8. Edmonton Series...	chiefly arenaceous, with lignite seams.
7. Bearpaw Shales ...	Estuarine and marine.
6. Belly River Group	Arenaceous, with coal seams.
5. Cloggett Shale.....	A great shale group. The Cardium sandstone consisting of only a few thin bands of coarser sediment.
4 Cardium Sandstone	
3. Benton Shales	
2. Dakota Beds.....	A mixed group with sandstones, shales, and limestones.
1. Kootanie Beds.....	Coal measures.

The Cretaceous formation is involved in the Rocky Mountains earth-movement, folding and contortion being intense in the mountains, less marked in the foothills, and dying out rapidly toward the prairie. Every part of this country has been prospected for petroleum. Of the various groups of strata, three are possibly petroliferous, the Edmonton series, the Belly River beds, and the Dakota-Kootanie groups. All these groups show signs of being oil-bearing, but it is toward the lowest horizon, that of the Dakota-Kootanie group, that most attention has been directed.

In the Athabaska River district at the north of Alberta, the Dakota-Kootanie groups are represented by coarse arenaceous beds, known as the tar-sands. Their thickness is sometimes as much as 200 ft. Seepages of heavy oil are frequent along the river sides, while gas is evolved briskly from the beds of the rivers at various places. The beds are nearly horizontal, and the undulations are hardly worth the dignity of the name of anticline. They are overlain by muskeg

and pine-forest, so that prospecting is difficult, and it is only on the water-courses that geological sections can be studied. Five wells have been sunk below Fort McKay, and all have yielded oil. The oil is heavy and sluggish in flow, but on distillation yields as much as 60% of light oils. Some of the wells have been continued below the tar-sands to the underlying Devonian rocks at depths of 800 to 900 ft. Gas and light oils have been encountered in several porous bands beneath hard cappings, and salt water occurs at more than one horizon. These light oils, however, do not occur in any great quantity, and are obviously filtered and derived from the younger oil-rocks above. The structure of the tar-sands is such that large yields cannot be obtained from wells, and it is probable that a more profitable scheme for working them would be to dig the sands by steam-shovel and extract the oil by one of the new low-temperature processes. Vast creek, in Alberta, shows of oil have been noticed for years, and a few years ago the Lineham well was the cause of a boom. Active prospecting is being conducted in this region at present, and the conditions are distinctly hopeful.

The evidence presented by the districts described above was such as to encourage the belief in the existence of oil along the eastern slopes of the Rockies throughout the length of Alberta, and prospecting was subsequently commenced in the central parts of the province. This region has since been called the Calgary oilfield. Between the latitudes of Edmonton and Lethbridge, no actual seepages had been discovered, though gas-wells were not uncommon, and springs of water having an odour or film of petroleum were occasionally observed. In the latter part of 1912, two independent syndicates commenced drilling on the same anticline at Okotoks, about 35 miles south



MAP OF WESTERN CANADA, SHOWING THE POSITION OF THE OIL DISTRICTS.

areas west of the Athabaska river present the same geological characteristics, so that the extent of the tar-sands must be great, though the absence of undulations forbids the expectation of any concentrated supply of petroleum. At certain points where the tar-sands are denuded and the Devonian rocks exposed, remnants of former impregnations of petroleum are found in joint-planes and porous beds. These occurrences have given rise to the incorrect idea that the Devonian formation is the source of petroleum in Western Canada.

The next area considered in Mr. Cunningham Craig's paper is that situated at the southeast corner of British Columbia and the adjoining southwest corner of Alberta, near the international boundary. On Flathead river, and its tributary Sage Creek, in British Columbia, numerous seepages of light oil have been observed and several shallow wells sunk. The earth movement here has been intense, and overthrust faults have brought the Devonian limestone above the Dakota-Kootanie series. Geologists are not enthusiastic as to the prospects here, but it remains for some one to drill below the Devonian in search of accumulations of oil in the Cretaceous beds underneath. On Pincher of Calgary. One of the syndicates, the MacDougal-Segur, sank a hole, the Dingman, near a gas-spring, and in the autumn of 1913 struck oil at a depth of 1562 ft. Then commenced the Calgary oil-boom, Only a small amount of oil flowed, but drilling was continued, and in May 1914 similar oil was encountered at 2718 ft. A second oil-boom followed. Mr. Cunningham Craig was on the spot when the second strike was made. The oil is remarkably light, a sample sent to London having the following analysis: Benzine 72% (sp. gr., 0·729), kerosene 20·02% (sp. gr., 0·714), solid paraffin 2·2% (sp. gr., 0 793), loss 5·3%. This oil is either a filtered product, or has been distilled from some other source and condensed. It can be used in crude form for motor purposes. The oil when coming from the well is accompanied by a strong gas. The well has produced 10 to 15 barrels per day. The geology of the district has been imperfectly understood. According to the Geological Survey maps, the well has its initial horizon in the Bearpaw Shales, and in that case, owing to the position of the well to the eastward of a sharp anticlinal crest, it can hardly have pierced beyond the Belly River beds at a depth of 2718 ft. But during the last

few months new paleontological evidence has been brought to light by Dr. J. P. Smith, of Leland Stanford university. His conclusion is that what were taken for Bearpaw Shales are really of Benton age. This means that the gas and light oil struck in the well must have their origin in the Kootanie beds. On anticlines farther west, wells are being drilled commencing low down in the Benton Shales, in the expectation of finding the Kootanie series in their petroliferous phase. Of wells in the vicinity of the Dingman, one sunk by the Calgary Petroleum Products Co. has tapped a flow of gas estimated at anything up to 2,000,000 cu. ft. per day, and another has had a showing of brown oil at 2200 ft. Mr. Cunningham Craig states that the future of the Calgary district is still in doubt. The view of geologists favours the assumption that, where so much gas and light oil is in evidence, bodies of heavier oil are to be found. It is desirable therefore to proceed carefully with development and prospecting, and in the meantime not to express any opinion for or against the possibilities of the future. As regards further explorations based on geological advice, it is possible to record that a well sunk 20 miles north of the Dingman has yielded an oil, with an analysis averaging 37% lubricating, 34·8% illuminating, and 20·6% light oils. This is a useful oil, if it can be obtained in quantity, and it is of a nature resembling that of a possible parent of the Dingman light oil.

The last oil occurrence of Western Canada described by Mr. Cunningham Craig is in the vicinity of Vancouver where a small seepage of light paraffin has been found in a Tertiary outcrop. The geological structure is not clear, but it appears to consist of a gentle monocline. No drilling has yet been done.

In concluding his paper Mr. Cunningham Craig referred to the wild boom in connection with the Calgary oilfield. He mentioned that people had been sinking bores in all sorts of places without any physical evidence of the existence of oil and without any scientific advice as to the possibilities at depth. These irresponsible operations have cast a shade of bad repute on Alberta that is quite undeserved.

Preventing the Blowing of Sand.—At the November meeting of the Chemical Metallurgical and Mining Society of South Africa, S. Newton read a paper describing the method adopted at Ferreira Deep for preventing the sand in the tailing-heaps being blown by wind. In the preliminary experiments, a great many materials had been used for damping or hardening the surface of the heaps, such as molasses, cement, slime-residue, oil, acid mine-water, and silicate of soda in combination with magnesium chloride. For various reasons all these materials failed to give satisfaction, on the score of either inefficiency or costliness. Finally, F. J. Trump, the manager, suggested the use of a solution of common salt, and it was found that the saturated solution gave a hard surface that lasted well. A further improvement was made at the suggestion of the metallurgical staff of the Rand Mines, whereby slime-residue was used instead of water. The present practice is to spray the heaps with slime-residue containing 56 to 60% moisture and 5 lb. salt per 100 lb. dry slime. This makes a strong and effective coating, and it has the advantage of being inexpensive, as the salt is a cheap local product, costing about 50s. per ton. The life of the coating depends on the degree of exposure to the prevailing winds and to the force of the latter. During the dry months August to October, it is necessary to spray three times a week. In the rainy season a coating will last for three or four weeks, and a good coating is more easily obtained when the sand is wet. On surfaces not exposed to the wind, it is not necessary to spray oftener than five or six weeks. The cost of material, power, labour, etc., is about 6d. per 1000 sq. ft. The superficial area treated at Ferreira Deep is about 600,000 sq. ft., and the cost per month is £25. The cost of erecting the plant was £900.

In the discussion, C. Toombs referred to the practice at the East Rand Proprietary, where a black clay mined on the spot is made into a pulp and sprayed. The clay is easily kept in suspension in water, and it penetrates into the sand, so forming a stronger protective covering than the slime-residue, which only forms a protective cake. Some members questioned the function of the salt, and it was stated that presumably it contained sufficient magnesium chloride to make it hygroscopic.

Copper Production.—The *Engineering and Mining Journal* for January 9 publishes statistics relating to the production of copper in America and throughout the world during 1914. For the first seven months of the year, the output was at approximately the same rate as during 1913. Afterward, the excision of Germany as a buyer of American copper made it necessary to reduce the output. The Anaconda and the porphyry mines curtailed their production by 50%, and the Calumet & Hecla and Phelps-Dodge mines reduced theirs by 25%. Many ceased production entirely, among which were the Cananea and the British Columbia Copper Co. It will be seen that the reduction of output in the United States over the whole year is 7%, or for the last five months about 17%. The output in Mexico shows a substantial reduction from 58,323 tons to 35,436 tons. During the year 1912 the output was 73,617 tons. The reduction is entirely due to the internal strife. The following tables give the output of copper by states, the output of American smelters, and the output of the world.

PRODUCTION OF COPPER IN THE UNITED STATES.
(As reported by Smelters.)

State.	1913 lb.	1914 lb.
Alaska	24,452,000	22,860,000
Arizona	399,849,745	374,371,075
California	32,390,272	29,018,200
Colorado	7,670,090	8,840,000
Idaho	8,434,028	5,983,538
Michigan	159,437,262	157,089,795
Montana	285,336,153	232,590,737
Nevada	84,683,961	59,760,906
New Mexico	46,953,414	66,041,251
Utah	147,591,955	150,446,231
Washington	448,805	141,023
East and South	24,333,014	18,351,927
Other states	4,155,135	10,236,135
Totals	1,225,735,834	1,135,730,818

OUTPUTS OF UNITED STATES SMELTERS.

Source.	1913 lb.	1914 lb.
North American ore	1,438,565,881	1,266,563,711
Foreign ore	55,803,202	52,277,948
Scrap	22,427,889	17,534,158
Totals	1,516,796,972	1,336,375,817
To foreign refiners	36,682,605	36,199,348
To American refiners	1,480,114,367	1,300,176,469
Crude copper imp't'd	169,315,869	126,188,945
Total crude copper	1,649,430,236	1,426,365,414

WORLD'S PRODUCTION OF COPPER (*a*)

Country	1913 Metric Tons	1914 Metric Tons
United States	555,990	515,164
Mexico	58,323	35,436
Canada	34,880	33,248
Cuba	3,381	6,628
Australasia	(*b*) 47,325	(*e*) 33,782
Peru	25,487	22,876
Chile	39,434	38,270
Bolivia	(*b*) 3,658	(*h*) 3,500
Japan	(*b*) 73,152	(*d*) 68,058
Russia	(*c*) 34,316	(*h*) 32,000
Germany	(*b*) 25,308	(*h*) 28,000
Africa	(*b*) 22,870	25,700
Spain and Portugal	(*b*) 54,696	(*i*) 47,500
Other countries	(*b*) 27,158	(*h*) 23,000
Totals	1,005,978	913,162

(*a*) The statistics in this table are compiled by the *Engineering and Mining Journal* except where noted to the contrary. (*b*) As reported by Henry R. Merton & Co. (*c*) As officially reported. (*d*) Privately communicated from Japan. (*e*) Exports as reported by Henry R. Merton & Co. (*h*) Estimated. (*i*) Communicated through London.

COPPER PRODUCTION IN CHILE.

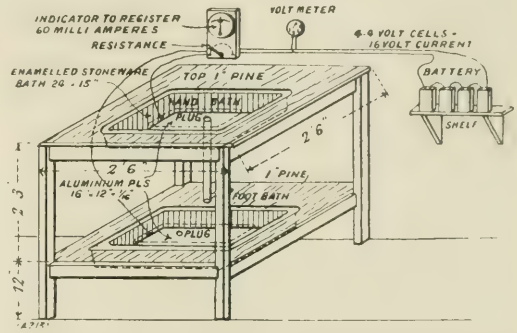
	1913 lb.	1914 lb.
Blister copper to U.S.	18,315,000	15,824,060
Copper in ore to U.S.	24,911,465	31,301,049
Copper to England and France	43,460,480	37,024,960
Sundries, estimated	250,000	220,000
Totals, lb.	86,936,645	84,370,069
Totals, metric tons	39,434	38,270

COPPER PRODUCTION IN PERU.

	1913 lb.	1914 lb.
Blister copper to U.S.	42,667,436	43,533,967
Copper in ore to U.S.	10,089,592	4,935,324
Copper to England and France	3,180,800	1,742,720
Sundries, estimated	250,000	220,000
Totals, lb.	56,187,828	50,432,011
Totals, metric tons	25,487	22,876

Lead-Poisoning.—*Engineering* for January 1 contains an article on lead poisoning at smelting and refining works, and mentions an apparatus recently installed by W. Robertson, manager of the Broken Hill Proprietary's smelter at Port Pirie, intended for the treatment of men showing symptoms of plumbism. This apparatus is designed on the system suggested in the *Lancet* a year or more ago by Dr. Thomas Oliver, of Newcastle-on-Tyne. It embodies the cataphoretic treatment, in which an electric current passed through the body ionizes the lead particles and makes them 'get on and get out.' The accompanying illustration explains the arrangement. The patient sits on a chair, resting his hands and feet in two shallow basins of enamelled stone-ware, which are filled with common-salt solution and hold aluminium plates as electrodes at the bottom. The hands are brought in contact with the aluminium plate that acts as cathode, and the feet are on the anode. The current passed is one of 25 to 40 milliamperes, at 16 volts. It is stated that the electrolyte becomes darkened and that black spots appear on the skin of the hands, presumably the colouring being due to the lead removed by the current. The treatment lasts about half-an-hour every day. Its efficacy is the cause of much discussion among medical men, and some of them have argued

ELECTRIC MEDICAL BATH FOR THE TREATMENT OF LEAD POISONING



that the theory is founded on an impossible assumption. Nevertheless the results obtained at Port Pirie appear to be promising. In any case the method deserves investigation.

CURRENT LITERATURE

[*Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.*]

Pumping on the Rand.—The January issue of the *Journal* of the South African Institution of Engineers contains a paper by E. G. Izod and A. P. Rouillard describing the centrifugal pumping-plant at the Durban Roodepoort Deep.

Tindall Hammer-Drill.—The *Iron & Coal Trades Review* for January 22 describes the Tindall hammer-drill, which is being used at a South Wales colliery for drilling in hard sandstone.

Electrically Driven Dredges.—The *Mining Press* for January 2 prints a paper by G. B. Rosenblatt on the application of electric motors to gold dredges.

Gold Mining in the Southern Appalachians.—In the *Mining Press* for January 9, W. R. Dodge describes the gold deposits in the southeastern states, Alabama, Georgia, and the Carolinas, and the present status of mining and milling.

Prospecting Wet Gravels.—In the *Mining Press* for January 9, Donald Steel describes a method of sampling wet gravels by means of shaft-linings consisting of telescopic caissons.

Cyaniding Concentrate at Treadwell.—In the *Mining and Scientific Press* for December 19, W. P. Lass gives the details of treatment cost at the plant where the pyritic concentrate is cyanided.

Tube-Mills.—In the *Mining Press* for January 2, Noel Cunningham gives a method for determining the tonnage handled by tube-mills in closed circuit with classifiers.

Tube-Mill Pebbles.—In the *Mining Press* for January 16, Edwin C. Eckel discusses the characteristics of pebbles used in tube-mills, and the possible sources of suitable pebbles in America, as substitutes for those hitherto imported from Denmark and elsewhere.

Flow through Spigots.—The January *Bulletin* of the American Institute of Mining Engineers contains

a paper by R. H. Richards and Boyd Dudley detailing experiments on the flow of sand and water through spigots.

Coal-Fired Reverberatories.—The January *Bulletin* of the American Institute of Mining Engineers contains a paper by David H. Browne describing the coal-fired reverberatory furnaces at Sudbury operated by the Canadian Copper Company.

Copper Queen Smelter.—In the *Engineering and Mining Journal* for January 2, Richard H. Vail describes the Copper Queen smelter, at Douglas, Arizona, belonging to Phelps, Dodge & Co.

Microscopical Examination of Coal.—At the December meeting of the South Staffordshire and Warwickshire Institute of Mining Engineers, James Lomax showed further microscopical evidence relating to the formation of coal. We referred to the work of Mr. Lomax in our issue of February 1912.

Gold-Quartz Veins in Lamphrophyre Dikes.—In the *Engineering and Mining Journal* for January 2, J. F. McLennan describes a type of ore deposit common in the Sierra Nevada and the interior Cordilleran region of North America, the gold-quartz vein following lamphrophyre dikes and sills in granite.

Laterite Deposits of Mozambique.—The *Geological Magazine* for December contains a paper by Arthur Holmes describing laterite deposits in Mozambique.

Laterite in French Guinea.—In the *Geological Magazine* for January, L. Leigh Fermor gives a translation, with notes, of A. Lacroix's paper published in the *Nouvelles Archives du Musée* on the laterite deposits of French Guinea, West Africa.

Yerranderie Mines.—In the December issue of the *Mining and Engineering Review*, H. Hardy Smith describes the present position of the Yerranderie lead-silver mining district, New South Wales.

Mount Elliott.—The January *Bulletin* of the American Institute of Mining Engineers contains a paper by W. H. Corbould describing the mining operations at the Mount Elliott group of copper mines, Queensland.

Electric Railway at Butte.—In the *Mining and Engineering World* for January 9, J. B. Cox describes the electrified railway connecting the Butte mines with Anaconda.

Llallagua Hydro-Electric Plant.—In the *Engineering and Mining Journal* for January 2, Mark R. Lamb describes the hydro-electric installation at the Llallagua tin mine, Bolivia.

Steel Manufacture in India.—In the *Mining Press* for January 16, C. M. Weld gives a historical account of the Tata Iron & Steel Company, of India, with information relating to the sources of the iron ore and of the coalfields of Bengal.

Magnesite Deposits in California.—In the *Mining Press* for January 16, Samuel H. Dolbear describes the magnesite deposits in California, which are attracting attention at present, owing to the interference of the war with the imports from Europe, India, and other countries.

Alaska Mining.—In the *Mining Press* a series of articles is being published, written by E. E. Hurja, describing the mining operations in Alaska. The articles give details of the work done in the various districts.

Natural Gas.—At the January meeting of the Institution of Mining and Metallurgy, J. A. L. Henderson and W. H. Henderson read a paper entitled, 'Inflammable Natural Gas as an Economic Mineral.'

Liquid Air.—In *Engineering* for January 22, a series of articles is commenced on the use of liquid air in industrial processes.

NEW BOOKS

The Deposits of the Useful Minerals and Rocks. Vol I. By F. Beyschlag, J. H. L. Vogt, and P. Krusch. Translated by S. J. Truscott. Cloth, octavo, 530 pages, illustrated. London: Macmillan & Co. Price 25s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

In 1909 appeared the first half of Volume I of the great work by Beyschlag, Krusch, and Vogt, entitled 'Die Lagerstätten der Nutzbaren Mineralien und Gesteine'; the second half was issued in 1910. The first and second halves of Vol. II appeared in 1912 and 1913 respectively. The third and concluding volume has not yet been published. To many students of ore deposits, who are readers of German, the contents of the two published volumes are already well known, but to those not conversant with the language, they have until lately been inaccessible. Recently, however, the translation of the work has been undertaken by Professor S. J. Truscott, of the Royal School of Mines, and the first volume of this English edition has now been issued under the title of 'The Deposits of the Useful Minerals and Rocks.' On the accomplishment of this self-imposed task Mr. Truscott deserves the congratulations and thanks of English-speaking geologists and engineers.

The subject matter of the volume falls into two nearly equal parts. The first deals with mineral deposits in general, and includes the description of their form and graphic representation, contents and structure, disturbance and alteration, each subject being exemplified by reference to actual deposits of mining importance in various parts of the world. The interesting questions of origin and classification are also discussed, and these deserve something more than passing reference.

Under origin, six processes are enumerated: crystallization from a magma, metasomatism, pneumatolysis, contact metamorphism, precipitation from solution (under and overground), mechanical concentration. As is well known these are often employed by economic geologists as the categories of a classification based upon mode of origin. The authors use mode of occurrence, a character often favoured by mining engineers, as the basis of their main divisions. Of these, four are instituted: magmatic segregations, contact deposits, cavity-fillings and replacements, and ore-beds. But inasmuch as the first and second of these include deposits originating by magmatic and contact metamorphic processes respectively, the third those arising by pneumatolysis, metasomatism, and precipitation from underground solutions, and the fourth those formed by precipitation from overground solutions and by mechanical concentration, the classification is also strictly genetic. It ingeniously combines therefore the demands of the economic geologist, on the one hand, with those of the practical miner on the other. Moreover, the groups and their sub-divisions are so arranged that there is a progressive passage from deposits having an obvious and direct connection with igneous activity, through others in which this connection is less and less direct, to those, finally, in the formation of which igneous action has played no direct part whatever. And in the later parts of the work the authors adopt this order in describing the important known deposits of the world. This classification is one of the most natural and scientific of the many that have been put forward, and is a notable feature of the work.

The second part of the volume is descriptive, and after disposing of magmatic segregations and contact

deposits, proceeds as far with cavity-fillings and replacements as the lodes of tin and mercury, leaving those less directly connected with igneous action, and the bedded deposits, for consideration in subsequent volumes.

The magmatic group is made both more and less inclusive than many would think desirable. Thus the deposits of Rio Tinto, as well as some others of controversial origin, are included here. On the other hand the pegmatite veins, notwithstanding their magmatic origin and their importance as sources of mica and other useful minerals, are omitted; so also are the corundum syenites of Canada

Under contact-deposits the authors include not only those universally regarded as belonging here, but also others, such as the iron deposits of Elba, the zinc-manganese deposits of New Jersey, and the silver-zinc-lead deposits of Broken Hill, concerning the origin of which there has been much difference of opinion.

When dealing with mineral bodies of pneumatolytic origin, no reference is made to kaolin deposits, although these rank among the most valuable of the products arising from pneumatolytic processes. This, and the previously mentioned omissions, call for criticism. If such deposits are omitted because their minerals are non-metallic, the title of the book should have been made less comprehensive, and for the sake of consistency, the relatively unimportant corundum peridotites and apatite lodes should also have been omitted; if because such minerals are to be dealt with in the final volume, this also is inconsistent, because their proper place, in the genetic scheme adopted, is here among other deposits of similar origin. It is high time that in treatises purporting to deal with the general geology of the useful minerals, deposits of the non-metallic minerals should be included, and should be considered in their appropriate places with the metalliferous deposits having a common origin with themselves. Any scientific classification that is sound for metalliferous deposits is sound for the non-metallic, and to ignore one group, or to treat the two groups as separate and independent, is to make an artificial distinction, and to obscure fundamental natural relationships.

A useful feature in the book is the full reference to relevant literature, preceding the discussions of the principal subjects.

In a brief translator's preface, Mr. Truscott, when discussing the English equivalents for certain German mining terms, refers to the loose and indefinite way in which the terms 'vein' and 'lode' have been used by British and American writers, and states his own views as to the signification that should be given to them. The more precise definition and use of mining terms, now that mining geology is attaining a place among the sciences, is necessary, and well-considered efforts of this kind are to be commended.

The work of translation has been admirably done. The sense of the original has been clearly brought out, and the rendering into English is excellent. It is rarely that such expressions as "It is only in but few cases . . . . . ." (p. 133), or "Though, however, this may be so, nevertheless . . . . . ." (p. 462) suggest an unnecessarily faithful adherence to the German periphrasis. The retention of 'lebererz' and 'korallenerz' when English expressions are already in use for these varieties of cinnabar seems undesirable; so too does the use of 'metasomatis' for the more usual 'metasomatism.' It would have been better also to use 'eruptive' as equivalent to 'volcanic,' and not as synonymous with 'igneous.' These criticisms, however, are trivial, and do not in any way detract from the value of Mr. Truscott's work, or lessen the services which he has rendered to English-speaking students of mining geology.

The publishers have not spared trouble or expense in the production of the volume. A commendable feature is the substitution throughout the work of English letter-press for German in the figures and diagrams. This must have been both troublesome and costly. Some would have preferred a thinner paper, and the critical might point out that the brief title "Ore Deposits," which appears on the back of the book, is by no means synonymous with that appearing on the title page. The second volume, which we understand has been translated, and is already in the press, will be awaited with much interest.

C. GILBERT CULLIS.

The Rare Earths: Their Occurrence, Chemistry, and Technology. By S. I. Levy. Cloth, octavo, 350 pages. London: Edward Arnold. Price 10s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is a technical book of high type, specializing on a subject of current interest and importance, and exhibiting great learning and research on the part of the author. Though scientific, it is written from the standpoint of the industrial chemist, who wants to know everything relating to the rare earths and their application to lighting by means of the incandescent gas mantle. The book is divided into three sections; the first dealing with the minerals containing zirconium, titanium, thorium, cerium, yttrium, and other metals of the cerium-yttrium groups; the second with the chemistry and properties of the metals and their compounds, and their separation and preparation; and the third with their industrial application. All three sections are full of interest and admirably written, and we find every aspect of the subject carefully and completely treated. The second and third sections in particular are of special value, as they give details of manufacture not hitherto published in dependable form.

The history of the development of the incandescent mantle is a long one. Ninety years ago Berzelius demonstrated that zirconia and thoria when heated in a non-luminous flame emit an intense white light, though long before that, similar behaviour had been observed with magnesia, alumina, lime, and zinc oxide. Zirconia was used in Paris in 1867 for illuminating purposes. Carl Auer von Welsbach commenced experimentation in 1880, and by patient research extending over eleven years found the mixture, 99% thoria and 1% ceria, which has proved so great a practical success. The search for thorium-cerium minerals, notably monazite, then received a tremendous impetus, and the presence of the rare earths was detected in multifarious place and circumstance. Monazite became an important article of commerce, and the fight for the control of the supply was international. Mr. Levy devotes a chapter to the technology of the construction of mantles and the preparation of cotton, ramie, artificial silk, and other fibres used in their manufacture. A final chapter gives information relating to other uses of the rare earths.

Electricity in Coal Mining. By David R. Shearer. Cloth, octavo, 90 pages, illustrated. New York: McGraw-Hill Book Co. Price 6s. 3d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This book gives information relating to American practice in electric haulage, coal-cutting, and lighting.

COMPANY REPORTS

Geevor Tin Mines.—This company was formed by Oliver Wethered in 1906 to develop tin mines adjacent to the Levant and Botallack, near St. Just, West Cornwall. Additional capital was raised in 1909 and 1911, and since then money has been obtained on loan. The classification and concentration plant, erected by American engineers, did not, under the conditions of operation, yield satisfactory results, and as the finances of the company were critical, the directors decided in April 1913 to revert to the methods customary in Cornwall. The report for the year ended September 30 last shows that 25,246 tons of ore was raised and treated, yielding 376 tons of concentrate, being an extraction of 33 lb. per ton. The income from the sale of concentrate was £34,431, the average price per ton being £91. 11s. 5d. The cost at the mine was £26,816, London expenses £1158, interest on loans £2442, allowance for depreciation of plant £1056, and net profit £2765. The year commenced with an adverse balance of £4657, and ended with an adverse balance of £1891. The issued capital of the company is £50,000, and there are £16,110 debentures, while £14,914 has been advanced on loan. Considering the fall in the price of tin, and the interruption of sales following the outbreak of war, the result of the year's working is not unsatisfactory. The development has been curtailed, and the reserve is estimated at 60,000 tons as against 78,000 tons the year before. The results of the work, however, have been uniformly promising. On the 5th level on the Pig lode, for 548 ft. the average content is 35 lb. over 42 in. The intermediate level between the 4th and 5th is also in ore of good quality, averaging 48 lb. per ton over 36 in. for a length of 721 ft. W. C. Williams, the manager, shows that as far as work has gone the width and content of the lodes are greater in depth than nearer the surface, and he recommends that development should be done in the lower levels rather than in the upper.

Tongkah Harbour Tin Dredging.—This company was formed eight years ago, under Tasmanian laws and under Australian control, for the purpose of dredging tin gravel on the sea-shore on Tongkah island, off the coast of the Western Siamese States, in the upper part of the Malay Peninsula. The report for the year ended September 30 last shows that an unusual amount of repairs to the dredges has considerably lessened the normal output. Two of the dredges worked only 60% of the time for this reason. Moreover one of the dredges sank in July, and the work of reclaiming it will be serious. A sixth dredge has just been erected and will have started work by now. The ground dredged during the year totalled 2,199,408 cu. yd. and the yield of concentrate was 1126 tons, comparing with 3,336,180 yards and 1339 tons the year before. The yield per yard was 1·147 lb. per yard as compared with 0·9 lb. The concentrate sold for £108,052 or £95. 19s. per ton, the price received per ton the year previous being £118. 7s. The working cost was £52,606 and administration expenses £7192. There was also paid £7000 to the Siamese government, as instalment of the purchase price and £6374 was allowed for depreciation. The shareholders received £52,500, being at the rate of 35%, part of it being paid from the balance brought forward from the previous year. On the outbreak of the war, the contract with the Eastern Smelting Co. was automatically suspended owing to the absence of quotations on the London Metal Exchange. Mining was, however, continued and the concentrate stored. Sales of concentrate were resumed in September. Payments to the Siamese government will cease during the current year, so that an additional £7000 per year will become available for distribution. Since the commencement of operations 6240 tons of concentrate has been won, and sold for £643,149, out of which £225,000 has been paid as dividends, being 150% on the capital of the company. Not one tenth of the area acquired has been dredged.

Broken Hill Block 10.—The report for the half-year ended September 30 last shows that mining and milling were suspended on August 19, the delivery of lead concentrate to German buyers ceasing on the outbreak of war, and the Amalgamated Zinc (De Bavay's) company not being able to take the zinc tailing, for the same reason. During the period of activity, 37,853 tons of ore averaging 11·2% lead, 12% zinc, and 8 oz. silver, was raised and sent to the concentrator. These figures of content are substantially lower than those for the previous half-year; in fact the assay-values have been steadily decreasing during the last few years. At the mill, 4799 tons of lead concentrate was recovered, averaging 65·8% lead, 5·7% zinc, and 29·7 oz. silver. The zinc tailing produced amounted to 33,054 tons, averaging 3·2% lead, 12·9% zinc, and 4·8 oz. silver. In addition 26,250 tons of old tailing and slime was sold. The accounts show an income of £57,280, and a net loss of £4691. Dividends amounting to £12,500, being 2s. 6d. per £10 share, were paid out of accumulated profits. The manager, O. B. Ward, has spent much time in New Guinea visiting properties under option to the company. We refer to these properties elsewhere in this issue.

Broken Hill Block 14.—The report of this company for the half-year ended September 30 shows that the policy of extracting carbonate ore from the remainders left in the upper levels has been continued with success, and that the winning of sulphide ore, resumed two years ago, has also yielded satisfactory results. The outbreak of war put an end to sulphide mining, but an arrangement with the Sulphide Corporation, as smelters, has made it possible to continue the mining of carbonate ore. During the half-year, 5062 tons of carbonate was raised, averaging 25% lead and 16⅜ oz. silver per ton, and the reserve of this ore appears still to be far from exhaustion. Of sulphide ore, 14,759 tons was mined during the four months of activity, averaging 15% lead, 11⅓% zinc, and 10·4 oz. silver. This was sold to the Junction North company. The accounts show an income of £37,113 from the sale of ore, and a net profit of £608. A dividend of £10,000, being 1s. per share, was paid on the ordinary shares, and £1500 was paid as interest on the preference shares. These distributions came out of the accumulated cash in hand.

Associated Northern Blocks.—This company was formed in 1899 to acquire the Iron Duke leases at Kalgoorlie, Western Australia. On the approaching exhaustion of the mine, three years ago, the Victorious property at Ora Banda 35 miles to the north was acquired. The report for the year ended September 30 shows that 7891 tons of ore yielding gold worth £18,705 was raised by tributers at the Iron Duke, and that 68,205 tons of residue was re-treated for a yield of £12,285. At the Victorious mine, 26,402 tons of oxidized ore was treated for a yield of £28,389. The mill was running for only four months, as the supply of oxidized ore became exhausted. Attention was then centred on the development of the sulphide zone and to the erection of plant suitable for the treatment of the sulphide ore. The plant was completed in December 1914, and the first returns are published in our Review of Mining. George M. Roberts has not an encouraging report to make on the ore reserves.

The assay-value of the ore is lower with each successive level from the 5th to the 7th, and the length of the shoot also diminishes. The lode is wider on the 7th level than in those above, but the gold is distributed in erratic fashion. Further examination of this level is desirable before deciding to sink below it. As regards ore reserve, Mr. Roberts does not give any estimate, but considers that there is sufficient to keep the mill fully employed for several months. The accounts show a profit of £3787 for the year, which added to the balance brought forward, makes a total balance of £27,654. Out of this, £23,957 has been allocated to expenditure on development and to allowance for depreciation.

Lena Goldfields.—This company was formed in 1908 by F. W. Baker and the Consolidated Gold Fields of South Africa to acquire a controlling interest in the gold worth £21,000,000. Last year C. W. Purington was appointed consulting engineer to the Lena company. He has made examination of the various properties, and under his direction R. E. Smith has conducted extensive testing of adjacent gravels. The policy in the future will be to attack the vast resources of lower-grade gravel by methods other than drifting, but the time is not propitious for embarking on any venture such as this requiring large amounts of additional capital. Mr. Purington estimates the reserve that can be worked by present methods at 4,144,490 cu. yd., containing gold worth £6,376,000, from which a profit of £864,200 can be made.

Northern Nigeria (Bauchi Tin) Mines.—This company was formed in the early part of 1910 to acquire, from the Anglo-Continental Mines, tin-gravel properties at N'Gel, near Naraguta, Nigeria. The report for the year ended June 30 last shows that 378 tons of tin concentrate was won by calabashing, as compared with 265 tons the year before. The amount marketed during the year was 405 tons, selling for an average of £116 per ton, as compared with £150 the year before. The result of working was a loss of £3629. Plans are now in hand for exploiting the deposits on a large scale, taking the poorer and richer parts together. For half of the year a jet elevator is to be used, and for the rest an oil-driven gravel-pump. Edmund Davis is in control, C. G. Lush & Co. are the consulting engineers, and A. R. Canning is the manager.

HAULING A BOILER TO THE LENA GOLDFIELDS.

Lenskoie company, a Russian organization working rich gold-gravels in the Bodaibo and other valleys adjacent to the Vitim river, a tributary of the Lena river in East Siberia. The report for the year ended September 30 last shows that the company now holds 66,682 Lenskoie shares valued at £1,419,339, being 60·62% of the capital of the Lenskoie company. During the year the company received £52,533 as dividend from the Lenskoie, earned during the year ended September 30, 1913. The receipts also included £26,045 interest on capital used in financing the Lenskoie. After payment of administration expenses and taxes, a profit of £50,558 was made, and £57,914 was distributed as dividend, being at the rate of 5%. The production of gold during the financial year ended September 30, 1913, was worth £1,251,254, obtained from 820,189 cubic yards of gravel, being a yield of 30s. 6d. per yard. The total cost incurred by the Lenskoie was £1,203,999, or 29s. 8d per yard. During the year ended September 30, 1914, the yield was £1,381,993 from 873,633 cubic yards. Up to date, the total production from the Lenskoie claims has been £19,216,444; the Industrial claims purchased in 1910 by the Lenskoie had before that time yielded

Central Chili Copper.—This company was formed in 1894 to work the Panulcillo copper mine near Coquimbo, Chile, that had been operated by previous owners since 1864. The shareholders in the company are chiefly resident in France. Berthold Schiff is manager. The report for the year 1913 shows that 28,624 metric tons of ore averaging 3·07% was raised, and 20,789 tons averaging 8·43% purchased. From this was produced matte containing 2274 tons of copper, and gold and silver worth £8725. The net profit was £4734. Neither the present company nor the old

Panulcillo company has distributed much in the way of dividends.

Knights Deep.—This company belongs to the Consolidated Gold Fields group and was formed in 1895 to acquire property on the dip of the Glencairn and Knight's, in the east central part of the Rand. In 1913 the Simmer East, which had previously been worked conjointly, was absorbed. The ore in these mines is of low grade, but the stopes being wide mining costs are also low. The report for the year ended July 31 shows that 1,112,800 tons was raised and the whole of it sent to the stamps without sorting. The yield of gold was 193,035 oz. worth £811,228, being 14s. 6d. per ton. The working cost was £675,363 or 12s. 1d. per ton, leaving a working profit of £135,865 or 2s. 5d. per ton. Out of this profit, £9280 was paid as contribution under the Phthisis Act, £4318 paid as debenture interest, £23,500 devoted to the redemption of debentures, £17,287 placed to capital expenditure, and £74,352 distributed as dividend, being at the rate of 10%. The ore reserve is estimated at 2,480,000 tons averaging 4·2 dwt. per ton. Preparations have been made for reclaiming ore left in the old stopes, and both walling and sand-filling have been adopted, partly for reclamation purposes and partly for general safety. The ground thus rendered available is, however, proving to be of lower assay-value than expected, and much of it cannot be classed as ore. It will therefore be impossible to keep the mill fully supplied without making arrangements to increase the amount of ore drawn from the stope-faces.

Wolhuter Gold Mine.—This company was formed in 1887 to acquire claims on the outcrop on the central Rand, to the east of the Meyer & Charlton. For a long time the career of the mine was chequered, and it was only in 1910 that the payment of substantial dividends commenced. The control is with S Neumann & Co. David Wilkinson is consulting engineer, and J. E. McGuire is manager. The report for the year ended October 31 shows that 426,390 tons was raised, and after the rejection of 10½% waste, 382,700 tons was milled. The yield of gold was £478,995 or 25s. per ton milled, and the working cost was £325,136 or 17s. per ton. As compared with the previous year, the ore milled was 41,750 tons greater, the yield per ton 1s. 5d. less, the cost 1s. 3d. less, and the working profit £14,459 greater. The working profit was £153,858, out of which £19,449 was allocated to capital expenditure, £10,955 paid as profits tax, £7931 paid as instalment on purchase price of undermining rights, and £7834 paid as contribution to the Phthisis Fund, etc. The shareholders received £107,500, being at the rate of 12½%. Development was pushed during the year, the figure being 15,410 ft. as compared with 10,849 ft. the year before, with the result that the ore reserve was raised from 784,100 tons averaging 6·1 dwt. to 999,400 tons averaging 5·9 dwt. The greater scale of development will be continued during the current year, especially in the eastern section, where the larger portion of the remaining unexplored area is situated.

New Lisbon-Berlyn.—This company was formed in 1885 to work gold mines in the Pilgrim's Rest district of the Transvaal. It has been reconstructed five times, and in 1906 the control passed to L. Ehrlich & Co. The reserve of oxidized ore was exhausted early in 1913, and since then attention has been devoted by Harold Sharpley, the manager, to the beneficiation of the pyritic ore. The report for the eighteen months ended March 31 last, now published, shows that plans have been matured for a treatment plant for the pyritic ore. The ore will be first crushed in rolls to $\frac{1}{16}$ in., and then roasted in Edwards furnaces. The copper will be leached by a weak solution of sulphuric acid, and will be subsequently precipitated electrolytically. The ore will then be re-ground, and the sand and slime cyanided. The average assay of the ore is 7·72 dwt. gold and 6·9 lb. copper per ton. The reserve is estimated at 89,348 tons. A hydro-electric plant is to be erected, utilizing a waterfall on Lisbon farm. New capital will have to be found for the purpose of erecting the metallurgical and electrical plant.

Middleburg Steam Coal & Coke.—This company was formed in 1902 under the laws of the Cape province to acquire coal deposits in the Middelburg district of the Transvaal, near the Witbank colliery, mentioned in the preceding paragraph. It was reconstructed in 1906 under English law. Dividends have been paid since 1909. The report for the year ended June 30 shows that the output was 280,547 tons, and the net profit £19,264, out of which £3245 was paid as preference dividend and £3542 as ordinary dividend, being at the rates of 5% and 3½% respectively. The shortage of railway trucks and the labour troubles interfered with the output, and the monthly figure was only 23,379 tons as compared with a capacity of 30,000 tons. E. M. Goodwin, the manager, reports that the plant is highly efficient, and that developments are satisfactory.

Witbank Colliery.—This company was formed in 1896 to acquire coal deposits in the Middelburg district of the Transvaal, about 90 miles east of Johannesburg. The sale of coal commenced in 1898, and increased gradually until 1909, since which time the yearly output has been fairly regular. Two mines are worked, the Witbank and the Uitspan. The control is with Neumann's, David Wilkinson is consulting engineer, and J. K. Addie is manager. The report for the year ended August 31 shows that 484,795 tons was raised from the Witbank and 291,111 tons from the Uitspan, a total of 775,906 tons. The profit for the year was £79,030, out of which £52,500 was paid as dividend, being at the rate of 25%. The haulage plant has been electrified and extended. Developments continue to be satisfactory, and bore-holes in advance of the working faces have proved the continuity of the beds.

Broomassie Mines.—This company was formed in 1901 to acquire a gold-mining property on the Ancobra river about 20 miles northwest of Tarkwa, West Africa. Two reconstructions have been necessary, the last in 1909, when Bewick, Moreing & Co. were appointed consulting engineers. After extensive development, milling was resumed in the early part of 1911. The first dividend, of 10%, was paid two years ago, and a second, at 20%, a year ago. The report for the year ended September 30 last shows that the costs have been higher, and no dividend is recommended. The costs were abnormally high during the earlier part of the period under review, owing to faults in the boilers and other plant, and matters have since been rectified. The development has been disappointing and little ore has been disclosed. During the year, 35,902 tons was raised and treated, and gold worth £141,140 extracted, as compared with 36,812 tons and £141,091 the year before. The profit, after every expense had been charged, was £6568, as compared with £43,246. The reserve in the West Reef is estimated at 11,644 tons averaging 20·4 dwt. per ton. In addition 120,000 tons has been developed on the East Reef, but the content is not specified, though it is stated that most of the ore now being milled comes from this lode. Development is being actively pushed, and A. M. Mackilligin is on the spot directing operations.

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Scientia non habet inimicum nisi ignorantem.

T. A. RICKARD, Editor. EDGAR RICKARD, Managing Director.

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STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
January 1914	621,902	29,851	651,753	2,768,470
February	597,545	28,716	626,261	2,660,186
March	657,708	29,093	686,801	2,917,346
April	655,607	28,270	683,877	2,904,924
May	689,259	30,970	720,229	3,059,340
June	688,232	29,694	717,926	3,049,558
July	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1914	154,202	9,471	11,979	175,652
February 28	157,673	9,508	12,266	179,447
March 31	162,815	9,619	13,390	185,824
April 30	165,005	9,625	14,150	188,780
May 31	165,433	9,619	14,284	189,336
June 30	166,248	9,442	13,256	188,946
July 31	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Cost per ton	Profit per ton	Working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
January 1914	1,902,733	27 4	18 2	9 3	876,577
February	1,861,442	26 10	17 11	8 10	823,654
March	2,094,098	26 4	17 3	9 1	945,000
April	2,075,561	26 6	17 3	9 3	955,600
May	2,196,287	26 3	17 0	9 3	1,011,968
June	2,178,161	25 5	17 1	9 5	1,025,629
July	2,281,717	25 10	16 9	9 1	1,032,562
August	2,261,800	25 5	16 8	8 9	988,567
September	2,188,939	25 11	16 9	9 1	989,859
October	2,301,795	25 8	16 8	8 9	1,004,264
November	2,192,365	26 3	17 0	9 0	982,346
December	2,167,056	25 11	17 3	8 6	917,662

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

Gold Output of India.

Year 1912	Year 1913	Year 1914	Feb. 1915	Year 1915
£2,265,094	£2,299,315	£2,340,259	£195,970	£397,225

Production of Gold in West Africa.

Year 1911	Year 1912	Year 1913	Year 1914	Jan. 1915
£1,069,442	£1,497,179	£1,634,700	£1,727,044	£143,649

Production of Gold in Rhodesia.

Year 1911	Year 1912	Year 1913	Year 1914	Jan. 1915
£2,647,894	£2,707,368	£2,903,267	£3,530,207	£293,133

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
January, 1914	9,762	102,261	112,023	475,840
February	8,493	94,812	103,305	438,809
March	1,173	91,446	92,619	393,418
April	8,774	90,233	99,007	420,553
May	7,138	99,068	106,206	451,132
June	1,725	99,290	101,015	429,081
July	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435,164
September	1,535	103,577	105,112	446,485
October	2,028	99,366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900

Other Australasian Gold Production.

	1912	1913	1914	Jan. 1915
	£	£	£	£
Victoria	2,039,400	1,847,400	1,740,300	69,900
Queensland	1,484,160	1,118,610	1,011,310	43,770

American Copper Producers' Association's Figures.
In Tons of 2240 lb.

	Production.	Deliveries: Domestic	Deliveries: Foreign	Deliveries: Total	Stocks at end of month
Total 1913	724,307	342,566	387,974	730,540	—
January 1914	58,826	21,409	39,266	60 675	38,933
February	54,715	21,244	37,455	58,699	34,949
March	65,023	31,184	39,983	71,167	28,805
April	67,634	28,315	36,761	65,076	31,363
May	63,530	24,818	32,460	57,278	37 615
June	63,101	20,637	32,745	53,382	47,334

No figures published since, and Association dissolved at end of 1914.

The United States Customs report exports as follows: July 34,145 tons, August 19,676 tons, September 23,866 tons, October 28,995 tons, November 1–28, 20,170 tons. December 7 to January 9, 24,366 tons. January 9 to February 6, 24,998 tons. No record is published of shipments between November 28 and December 7.

Nigerian Tin Production.
In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Dec., 1914 tons	Year 1914 tons
2,532	5,032	326	4,832

Production of Tin in Federated Malay States.
Estimated at 70% of concentrate shipped to smelters.

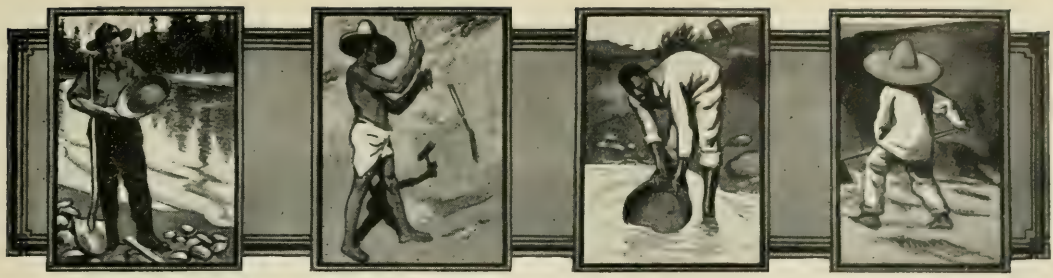
1911 tons	1912 tons	1913 tons	1914 tons	Jan. 1915 tons
43,967	48,250	50,128	49,042	4,395

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January 4, 1915	328¾	£28,353	£86 4 11
January 18	214¼	£18,785	£87 13 8
February 1	215¾	£19,892	£96 13 8
February 15	227½	£21,801	£95 16 7
March 1	218¼	£21,208	£97 3 5

Imports of Tin Concentrate at Liverpool.
Reported by H. A. Watson & Co.

	Bolivia tons	Nigeria tons	S. Africa tons
January—Concentrate	4188	447	308
Metal Content	2513	313	216
February—			
Concentrate	4801	621	66
Metal Content	2881	435	46



REVIEW OF MINING

INTRODUCTORY.—In spite of the restricted conditions of dealing on the Stock Exchange, the mining market has continued to improve and affairs can even be described as lively. The mines in the far east Rand are a centre of attraction. The facts that the controllers of Springs Mines have been able to secure the financial assistance of their bankers in providing the remainder of the capital required, and that the directors of New Modderfontein have decided to proceed with the erection of the additional metallurgical plant, are taken as indications that the economic balance in the Transvaal has been restored. The Broken Hill group has been strong on the satisfactory arrangements for co-operative lead-smelting between three of the big producers, and on the news that zinc concentrate is being shipped for treatment to America. Mexican shares have been seriously depressed by the news that the mines in the El Oro district have been closed. The Cornish tin-mining companies have been able to weather the war-storm effectually. Admiration must be expressed for the financial support so loyally given to the mines by the Bolitho family, when difficulties arose in connection with the disposal of the black tin, and equal praise is due to the managers and staffs of the companies for their pluck and determination at a time of crisis. The German "blockade," and the answer of the English Government with a real blockade, followed by the Dutch prohibition of the export of copper and the refusal of Dutch, Danish, and Norwegian shipowners to carry German goods, have conduced to the formation of a general opinion that the period of war will be shortened, and financial conditions are thereby greatly relieved.

TRANSVAAL.—The figures for the output of gold during January, £3,037,058, were greater than expected. It was thought that the interruptions caused by floods in the west Rand and in the Pilgrim's Rest district would have reduced the output. As an offset, the influx of labour by 7681, bringing the figure to 172,331 on January 31, was the cause of a great number of individually small increases, so that the value of the total output was £84,303 higher than in December. The output of gold during February was 653,213 oz. on the Rand and 23,008 oz. in outlying districts, having a total value of £2,872,406. The number of native workers on February 28 on the gold mines was 180,422, a rise of 8091 as compared with the previous month.

The directors of Springs Mines have arranged a loan with their bankers for the provision of £315,000 additional capital for completing the development and plant. The loan is guaranteed jointly by the Transvaal Coal Trust and the Consolidated Mines Selection Company. The Barnatos are purchasing an interest in this company.

The Modder Deep ore reserve on January 1 was estimated at 2,450,000 tons averaging 8 dwt. per ton over 69 inches. At the other Goerz mine in the same neighbourhood, the Geduld, the reserve is estimated at 1,900,000 tons averaging 7·1 dwt. over 59 inches.

Repairs to the Bantjes Consolidated cen-

tral shaft, which was damaged by floods, have progressed sufficiently to allow the resumption of hoisting in two compartments. The quarterly report for the period ended December 31 states that development has been disappointing, though the latest work shows a slight improvement in the assay-value.

The floods in the west Rand during February filled many of the workings of the Randfontein Central, and the amount of ore treated was curtailed. The Crown Mines yield per ton continues at the low level recorded in our last issue.

RHODESIA.—While the output of gold in January was the lowest recorded since May, it is £44,000 higher than in the first month of last year. The Bell Reef decreased from £7106 to £1145, and the Transvaal & Rhodesian Estates from £5650 to £3700, while the Globe & Phœnix declined from £43,586 to £35,434. On the other hand, the Shamva did well, reaching an output of £31,472 from 48,043 tons.

The Falcon copper-gold mine has provided much opportunity for discussion in connection with the assay-value of the ore reserve. The engineers now state that the results obtained at the smelter fully confirm their own estimates and falsify the figures given by the visiting valuers. As the plant has not been running long, the claim of confirmation is premature. The financial position of the company is none too strong. The issued capital is £400,000, of which half represents cash subscribed, and debentures for £250,000 have been issued. The balance-sheet published last month shows items: Loan and interest £63,420, sundry creditors £43,258, and bills payable £85,000. The directors state that additional debentures for £50,000 have been issued to satisfy a loan; at the same time they announce that further capital is required to complete the plant. The estimated working profit on the reserve of ore is about £500,000, but the engineer's figures for working cost have not yet been realized, and no note is made of the other inevitable costs. It will be seen, therefore, that the prospective return to shareholders from the ore reserves will be much less than the outlay.

WEST AFRICA.—The production of gold in January was slightly less than in December, and was only £14,787 higher than in the previous January. The Abbontiakoon decreased its output by £3311 and the Prestea by a like amount.

The Jos Tin Area Company's yearly report states that the bucket-dredge recovered 252 tons from 117,021 cubic yards from the time of starting until July 31 last, a yield of nearly 5 lb. per yard. The output of the dredge for February was 40·9 tons from 19,150 cubic yards, being 4·7 lb. per yard.

AUSTRALASIA.—A year ago we recorded that a scheme was in hand whereby the North and South companies at Broken Hill would acquire a share in the ownership of the Proprietary's smelter at Port Pirie. This scheme was necessarily postponed owing to the war, but its discussion has since been revived, and a preliminary basis of agreement has been settled.

The Broken Hill South company reports a production, during the second half of 1914, of 20,375 tons of lead concentrate from 112,750 tons of ore, as compared with 28,745 tons from 172,330 tons during the first half of the year. Zinc tailing was sold to the Amalgamated Zinc for £24,000. The profit for the half-year was £54,000, and a dividend was paid at the rate of 3 shillings per £1 share, absorbing £30,000.

The Broken Hill Proprietary sent its first consignment of zinc concentrate to the United States at the beginning of February, the delivery being at the port of Mobile for smelters in the Mississippi valley. The Sulphide Corporation is conducting negotiations with the same object in view.

Last month we mentioned that the Broken

Hill Proprietary had received orders for steel rails from the New South Wales and South Australian Governments. We are informed that the rails ordered by the former are to be used in the construction of the line connecting Broken Hill with Condobolin. It will be remembered that Broken Hill is isolated from the railway system of New South Wales, and that the approach to tide-water is through South Australia. The new line will cross the Darling river at Menindie, which is about 300 miles west of Condobolin, the terminus of one of the railways from Sydney.

The Hampden Cloncurry Company reports that in the north drift on the 350-feet level from the No. 3 shaft of the Hampden mine the ore averages 10% copper over the width of the drift, 79 inches. The drift is not the full width of the lode, on either side. At the Duchess mine, the north drift on the 700-ft. level is in ore assaying 30% copper over 8½ feet.

We are occasionally asked to quote specific instances of the minimum precious-metal content of blister copper that warrants extraction by electrolytic refining. As a case in point we may quote the Hampden Cloncurry copper. This contains one third of an ounce of gold and 8½ ounces of silver per ton, the income from the sale of which is £2. 7s. per ton of copper. The chairman of the company stated the other day that this content did not do much more than pay for the cost of extraction, and that if the yield was a trifle lower, it would be better policy to make standard copper instead of sending the blister copper to be refined.

A scheme has been prepared for working the Great Cobar for the benefit of the debenture-holders. Mr. W. Pellew-Harvey reports that the ore reserve is sufficient to repay the debentures, with a profit, within three years.

A year ago we recorded the decision of the directors and managers of the Tasmania gold mine to suspend operations, owing to the capital outlay and current cost being greater than was warranted by the reserves in the lower levels. Subsequently the Tasmanian Government acquired the lease, intending to help the employees to work the mine on a co-operative basis. Six months trial of this scheme proved a failure. Tentative proposals on the part of other buyers have come to nothing, so the company is to be wound-up and the assets placed in the hands of a receiver. The accumulated concentrate and slime will take four years to treat and should yield a profit of £40,000. The winding and pumping plant is to be sold as opportunity offers. Some difficulty will be experienced in finding a customer for the pumping plant, for it is one of the largest ever installed at a mine.

The Great Boulder ore reserve was estimated on December 31 at 560,647 tons averaging 14·85 dwt., as compared with 615,114 tons averaging 14·59 dwt. the year before. Allowing for the extraction of 190,000 tons during the year, these figures indicate that 130,000 tons was disclosed, no bad performance for a mine whose days are numbered.

INDIA.—The Jibutil mine in the Anantapur district is requiring more capital, as it must be worked on a larger scale if it is to be profitable. The development of the property has been conducted on cautious principles by the managers, John Taylor & Sons, and shareholders have been asked to subscribe only small amounts at a time. The metallurgical plant started in September 1913, but owing to the unsatisfactory service of the Diesel oil-engine regular running was impossible before May 1914. Recent development has disclosed ore on the 1000-ft. level. Plans are now being prepared for extending the exploratory and development work in order substantially to increase the ore reserve, and a scheme for raising capital for this purpose is to be submitted to the shareholders. The North Anan-

tapur mill has been closed for a few weeks during the reorganization of the cyanide plant.

The yearly report of the Mysore mine shows that gold to the value of £899,498 was extracted from 304,375 tons of ore. The yield is not much different from the yields during the five previous years, but the amount of ore required to maintain this yield has risen from 275,996 short tons in 1910 to 304,375 short tons in 1914. The ore reserve has suffered reduction, for the reason that development had to be suspended during the drought from March to June of last year. The estimated figure represents three years' supply, of a grade fully equal to that now being milled. Mention is made also of 250,000 tons of low-grade ore, which will probably be milled, as it may contain pockets of ore of higher grade. Recent developments in the south end of the mine have not been encouraging, but in the northern workings from the Ribblesdale auxiliary shaft, some excellent ore has been exposed. Rich ore continues to be found in Tennant's section.

CANADA.—The information concerning recent development work in the Casey Cobalt mine came just too late for our last issue. It is important as indicating the possible extension of the productive area usually associated with the Cobalt district, although as a matter of fact it is 20 miles distant, while geologically similar. The native silver found in the drill-cores last June has been followed by systematic mine exploration, resulting in the cutting of several stringers, one of which is so rich as to be highly promising. We commend the engineer, Mr. D'Arcy Weatherbe, for his caution in stating that these discoveries "while encouraging, as indicating an area of argentiferous fissuring, can hardly be said to have so far developed orebodies of important commercial value."

UNITED STATES. — On February 11 the Alaska Gold Mines started its mill, of 8000-tons daily capacity, and so brought 2½ years of development to fruition. We hope this big enterprise near Juneau will be completely successful, for, if it is, it will lead to vigorous exploratory work and larger developments in the Alaskan schist range.

The new smelting plant of the Arizona Copper Company attained its full efficiency with an output of 1600 tons per month just before the outbreak of war. It was deemed advisable to reduce the output to 1200 tons during the anxious months from August to December. At the beginning of January the works reverted to full capacity, and the yield during February was 1600 tons. The applicability of the flotation process to the treatment of tailing is being tested. The increase of taxation in Arizona is reflected by the fact that the company paid $65,060 in 1910 and £180,157 in 1914.

Minerals Separation has made a contract with the Anaconda Copper Mining Company granting the licence of the agitation-froth flotation process. The plant is to have a capacity of 2400 tons per day, and will be divided into 24 units of 100 tons each. Probably no mining company ever spent so much time and money in investigating concentration problems. Our readers will remember the series of papers on this subject written by members of the Anaconda staff in 1913. So that the tests of the Mineral Separation process have been fully competitive.

MEXICO.—The crisis in El Oro district has once more become acute and all the gold mines are closed. The English families have removed and only a few of the staff remain to take care of the properties. The political position in Mexico is rapidly becoming worse, and the Carranza regime in the capital is so bad as to rouse even President Wilson's impatience and indignation.

RUSSIA.—Prospecting by bore-hole at the Degtiarsky property belonging to the Sissert company warrants the estimate of 1,084,000 tons of ore averaging 3% copper and 6 shillings

in gold and silver per ton. The depth to which boring has been carried so far varies from 340 to 450 feet. Additional holes have been commenced in order to test the extension in depth. Two shafts, called the London and Petrograd, are being sunk, and at the end of January were 126 and 138 feet deep respectively.

At the Kyshtim property, the Amerikansky orebody has been proved by No. 12 bore-hole, sunk at a distance of 500 feet north of No. 11. The lode was intersected at a depth of 735 feet, where the ore, consisting of massive pyrite, was found to be 19 feet wide on the horizontal measurement, and to average 4·5% copper, 3 dwt. gold, and 2 oz. silver per ton. The previous bore-holes had proved the lode for 750 feet, so that the latest results indicate an important extension of the orebody.

VARIOUS.—The operations of the Anglo-Colombian Development Co., a Consolidated Gold Fields subsidiary, have a technical interest, being an exploitation of platinum in gold-bearing gravel. This phase of alluvial mining, as in the Ural, has followed upon ordinary gold-washing by natives. The chief constituent of the heavy gravel is a rock in which hornblende, augite, and calcite predominate ; while at the head of the watershed a rock rich in olivine, and resembling dunite, suggests the probable matrix of the platinum. The alluvial deposit is from 20 to 25 feet thick, and rests on a bedrock of hornblendic schist, decomposed to clay on top. The platiniferous layer often lies 10 or 12 feet above bedrock, the position being determined probably by imperviousness caused by clay in the gravel. Boring operations with Empire drills on the Condoto and Iró valleys have been in progress for three years, and a 7-ft. bucket-dredge is now on the ground. Mr. C. J. Inder, of Inder & Henderson, is the engineer in charge. The ratio of gold to platinum exhibits marked variation as between the different rivers in this main watershed of the San Juan, which enters the sea at Buenaventura, the port of entry. The region is at about 500 feet altitude, and is subject to copious rainfall, namely, 20 to 25 inches per month, almost entirely at night.

The Malayan Tin Dredging company operating in the southern part of Perak state has decided to proceed with the erection of the fourth dredge, as the troubles of the tin market have disappeared.

Judging by the reports issued by several mining companies, no difficulty is experienced in selling wolfram concentrate in this country. The Wolfram Mining and Smelting Company, operating in Portugal, was able to find a market here shortly after the termination of the sale contracts with German buyers. The Cornish mines have a similar tale to tell.

The Tavoy district in Southern Burma is recovering from the fear that prices would slump. The wolframite output is even being increased. With the price of tungstic acid steady at from 30s. to 31s. per unit, and with the assurance from the Secretary of State that the High Speed Steel Alloys Ltd.—a newly organized British firm of leading ordnance and armour-plate manufacturers with works at Widnes, Lancashire — requires 100 tons monthly of high-grade wolframite, it is hoped locally that a concerted move will be made by the Chamber of Mines to guarantee the tonnage required and to induce the Government of Burma to give more effective help to the mining industry. Limitation of acreage held by one company or individual is a step in the right direction. The making of feeder roads, the prohibition of mining under prospecting licences, keeping proper record-books, plans, and sections, and the installation in Tavoy of a magnetic separator as a Government custom-plant are greatly needed improvements, all of which would be of incalculable help in developing an unusually rich wolframite district.

The Pahang Consolidated owns the only lode-tin mines of note in the Malay Peninsula.

The development during the last two years at Willink's mine, the chief of the group, has been highly gratifying. The effect of the improvement on the 500-ft. level is reflected in the figures for the average yield of black tin during the last financial year, 1½%, as compared with 1% during the previous year. The Pahang is a big producer; during the past year the output of black tin was 2200 tons.

CORNWALL. — Our Camborne correspondent gives details of the results of half-year's work at the chief tin mines in Cornwall. The mines did wonderfully well during the months following the outbreak of the war, in spite of the entire absence of a tin market at first, and of low bids for black tin subsequently. The situation was saved by the action of the firm of Thomas Bolitho & Sons, of Penzance, who advanced money on the security of the black tin produced. As an instance of this aid, we may mention that Dolcoath availed itself of the offer to the extent of £13,000.

We regret that the Schiff group has gone under, and that these companies have had to seek the protection of the Bankruptcy Court. Wheal Jane, belonging to Falmouth Consolidated, ceased work some months ago, and the boast of the chairman about the resources warranting the erection of 1000 stamps is finally falsified. The St. Agnes Consolidated did little good at Wheal Kitty, where the manager was left to his own resources as regards raising ore and paying employees. St. Ives Consolidated spent far too much money on surface plant, and too little on underground development at the only hopeful prospect, the Giew. The British Radium Corporation has also had to go into the hands of a receiver. This company was formed to produce radium from the pitchblende found on the dumps at Trenwith, near St. Ives, and Sir William Ramsay was engaged to direct the technology of the extraction process. Last summer Mr. Arthur Schiff had made contracts on behalf of this company to supply radium bromide to medical universities in Germany. Naturally such prospects as the company had were ruined by the outbreak of war.

The relations between the mines and smelters in Cornwall are growing more difficult, and the fortnightly ticketings are more and more considered to constitute unreal competition, owing to only three smelters making bids nowadays. Williams, Harvey & Co. have closed their works at Hayle and do all their smelting at Bootle, near Liverpool. Owing to the difficulty of finding ships to take black tin from Cornwall to Liverpool, and to the impossibility of standing railway charges for its transport, this firm has withdrawn from the ticketings, and depends on Bolivian and African concentrates. Mr. John Gilbert, agent for Lord Clifden, has stated publicly that he is in favour of co-operative smelting for the benefit of Cornish mines. Mr. J. H. Bain has declared his willingness to smelt on a co-operative basis at his works at Redruth, but the mines do not take him quite seriously. There is a movement to acquire Bolitho's plant at Penzance, which has been idle for three years, and we understand that capital is forthcoming for this purpose, if the intending purchasers agree on the policy to be pursued.

METALS.—The copper market has exhibited little change during the month. Standard is quoted at £64 per ton and electrolytic at £69. Tin has advanced in price and is quoted at £185 per ton cash and £163 for three months. Lead continues firm at about £20 per ton. The price of zinc is £45, or double what it was before the war. Some zinc concentrate is now going from Broken Hill to America, where the demand for zinc is strong, owing to the extensive use of brass in the manufacture of war material for the Allies. Antimony is quoted at £75 per ton. The price of Spanish quicksilver is £12. 5s. per flask of 75 lb. Silver has advanced slightly to 23½d. per standard ounce.

EDITORIAL

DIVERS spellings of the mineralogical name of iron sulphide were discussed at the Institution's last meeting. Whether it should be 'pyrite' or 'pyrites' we do not care to say on this occasion: as the discussion took place on February 18, 1915, we suggest 'pirate' as the appropriate spelling.

VISITORS to the laboratories and lecture-rooms of the Royal School of Mines will find them almost deserted, for our young miners are using the spade in the trenches. Of the students remaining, a large proportion are Chinese and Japanese, some of whom came to London from the Belgian technical schools.

CONTRARY to rumour, the International Engineering Congress, scheduled for September 20 to 25, at San Francisco, has not been abandoned. On the contrary, the five American engineering societies, under whose auspices the Congress is to be held, have resolved unanimously to confirm their original pledge to support the Congress.

READERS of this Magazine are aware that the memory of S. F. Emmons has been honoured by the foundation of a fellowship to promote investigation in those branches of geology to which he was particularly devoted. The funds contributed by his friends have been placed in charge of the Trustees of Columbia University, but the choice of the annual recipient and the expenditure of the income have been entrusted to Professors James F. Kemp, John D. Irving, and Waldemar Lindgren. A fellowship of $1000 will be awarded in March for the year beginning July 1, 1915. Thus Emmons will be remembered in a manner that he would, we think, himself have chosen.

W. W. WATTS, Professor of Geology in the Imperial College of Science and Technology, has been awarded the Murchison medal of the Geological Society. The bestowal of the honour is one that will please many of our readers. Professor Watts is a worthy successor of John Wesley Judd, and more than that we could not say.

ENGINEERS, whether working above or under the ground, on land, sea, or air, will be glad to hear that the Admiralty has decided at last to give the engineer officers of the Navy the same status as those in the executive and navigating departments. It is obviously just and appropriate, and it is an event of far-reaching importance. Mr. Lloyd George said "This is an engineers' war." It is indeed; and when the war is over the engineer will prove that while the work of destruction may be a duty, the work of construction is a delight.

WE are informed that the gold medal of the Institution has been awarded to Mr. Willet G. Miller, Provincial Geologist of Ontario. This award will give keen pleasure to many besides the recipient. In our July issue, in referring to recent developments at Cobalt, we laid stress on the great usefulness of Mr. Miller's pioneer work in diagnosing the geological structure of that district in its

very infancy. Elsewhere in Ontario he has done work of immediate practical usefulness. We suggest that the medal should be made of Ontario gold.

WE are proud to record the fact that an Associate of the Royal School of Mines, Mr. George Schack-Sommer, has won the Cross of St. George while fighting with the Russian Army in the Carpathians. Mr. Schack-Sommer was an assayer and cyanide-operator at the Tanalyk mine when war was declared. He offered his services to the Russian authorities and joined, in November, the 12 Artirsky Hussars. At first he served in Galicia and then went with his regiment through the Dukla pass in the Carpathians, where he distinguished himself greatly, by reconnoitring the Austrian artillery and fighting his way back at the head of a scouting party.

IN presenting his paper, at the last meeting of the Institution of Mining and Metallurgy, describing gold ore found at Ashanti, Mr. J. Morrow Campbell delighted his hearers with two examples of precision. In the first place the coloured lantern slides prepared from micro-photographs showed extraordinarily careful work on his part, and, secondly, his plea for systematic terminology in connection with minerals was evidence of a sincere desire to think and speak accurately. He had our full sympathy in his protest against the liberties taken, by the printers, with his logical usage of terms. Should any of the readers of his paper imagine that Mr. Campbell favours the word 'arsenopyrites,' we beg to disavow on his behalf any such inclination, and we recommend them to study his remarks on 'pyrite' and 'pyrites' in the March bulletin.

MR. W. G. Holford's paper, read at the same meeting of the Institution, discussed the engineering problems in the development of the gold-bearing banket in the far east Rand. Though the paper was properly criticized in many points of detail, it served the excellent purpose of drawing attention once more to the comparative advantages of round and rectangular shafts, as applied to metal mining. This is a question that deserves closer study and consideration than it usually receives. Some years ago the Institution offered a premium for the best paper on the subject, but it was never awarded; whether the papers did not come up to standard, or whether none was received, we do not know. When the Modderfontein B company decided to adopt this form of shaft, we discussed the scope of the system in an editorial in our issue of January 1911. Unfortunately none of our readers seconded us in our endeavour to elucidate matters. Subsequently we gave a short description, with drawings, of the circular shaft at the Champion Reef mine in India.

LODE MINING in the Yukon is the subject of a bulletin just issued by the Canadian Department of Mines. The author is Mr. T. A. MacLean. The subject is one of unquestioned interest. Nobody acquainted with the richness of the alluvial deposits in the Yukon, especially in the valleys of the Klondike watershed, can have failed to wonder whether the source of this gold would be found in neighbouring quartz veins of commensurate richness. That expectation has been repeatedly falsified; yet the existence of sundry gold-bearing veins has been demonstrated and small-scale mining operations have been conducted in a desultory way for many years. No big discovery has been made, but the official opinion, as given in this report, is that a number of the finds have a chance of becoming productive mines. The best of them are in the southern Yukon, where the gold exists in association with silver-bearing galena in quartz lodes.

ALTHOUGH not among the admirers of Mr. Bonar Law as a statesman, we recognize his ability as a man of business, and find ourselves wholly in sympathy when he protests—as he did in the House of Commons on February 11—against the contempt shown by politicians for the intellectual quality of business men. It has been one of the anomalies of these critical times that the administrative ability of the City has been so inadequately used in the public service. Messrs. E. A. Ridsdale of the Red Cross, F. W. Baker of the St. John Ambulance, and H. C. Hoover of the Belgian Relief Commission are among the names that leap to mind in this context, as business men that have had the exceptional chance to prove their great usefulness during the period of the war. At a time when we must all pull together, it is a thousand pities that the experience of the City is not more liberally utilized by those in authority.

IN our January issue, when discussing the metal trade, we referred to the Government employment—as metal buyers—"of English representatives of German firms." We are informed that James & Shakspeare, a thoroughly British firm, is the official broker to the Government. Henry R. Merton & Co., often mentioned in this connection, is a British firm with German affiliations; this business was founded about 56 years ago by Henry R. Merton, and it was his brother, Mr. William Merton, that started the Metallgesellschaft at Frankfurt. Moreover, we are assured that the writs of libel obtained against two London papers, notably *The Globe*, were not intended to block further criticism. The management of *The Globe* is opposed to the Government and is endeavouring to create a demand for the establishment of a Minister of Commerce. On the other hand, we reiterate our opinion that the interlocking of the metal trade, even when conducted on non-national lines, is highly prejudicial to the mining industry, especially of Australia. We should like to see an impartial official inquiry into the position.

MUCH nonsense is being talked concerning the export of nickel from the Sudbury mines, in Canada. The desire to prevent any metal produced from the Dominion reaching the enemy is proper enough, but when patriotism is made a stalking-horse for attacking the International Nickel Company, we cease to sympathize. Every assurance has been given and every safeguard provided against the delivery of Canadian nickel to Germany, yet the agitation continues. The latest idea is to compel the smelting and refining of the matte in Ontario, instead of New Jersey, whither it now goes. As half of the total nickel produced by the Sudbury mines is consumed in the United States and as a duty of 10% is imposed on the metal, as against free importation of matte, it is fairly obvious that a great injustice will be done to an important industry. Economic conditions in Ontario are, we believe, wholly unfavourable to the profitable operation of a refinery, as compared with the one now in operation in New Jersey. Other points arise, and for them we refer our readers to the February 13 issue of the *Mining Press*. On the face of it, the motives underlying the continued agitation in Canada on this nickel question are open to grave suspicion.

ON February 20 the Panama-Pacific International Exposition was opened at San Francisco, the President of the United States at Washington pressing an electric button that started the machinery into life and activity. The formal inauguration of the Panama Canal has been postponed until July, but this need not interfere with the success of the exhibition itself. Wars and rumours of wars will restrict international participa-

tion, but the Exposition should receive intensified domestic support, since ordinary tourist travel to Europe is under embargo. The site and buildings are of unusual beauty, overlooking the Golden Gate and the splendid bay of San Francisco. Money has been spent lavishly, and with taste, in creating a fairy city worthy of a historic event and of a romantic locality. We publish a short account of the Canadian mineral exhibit; we have seen the splendid model of the Modderfontein B mine and the polished samples of banket that are being sent by the Central Mining and Investment Corporation. Undoubtedly the mining, metallurgical, and mineral displays will be of unusual excellence. San Francisco is an important mining centre, and will attract a large attendance from the adjacent mineral regions.

Dolcoath and Deeper Mining.

The recent meeting of the proprietary of this famous Cornish mine was rendered interesting by a discussion on the advisability of deeper exploration. In addition to this feature, the proceedings appealed to us as exemplifying a company meeting at its best. Only too often these assemblings of shareholders smack of *opéra bouffe* or vaudeville: they lack sincerity; they represent window-dressing of meretricious character; they suggest that directors look upon shareholders as necessary evils, and that shareholders have no confidence in their nominal trustees. It is not so in the case of this honourable enterprise. For the chairman of Dolcoath, Mr. Frank Harvey, the shareholders have, as we have, a sincere respect; he represents the best of the old school of business men conversant with mining affairs. The vice-chairman, Mr. Oliver Wethered, one of the founders of the present company, is a mining operator to whose cheery optimism we may have demurred on occasion, but never his sincerity or his capacity for hard work. To him Dolcoath, and other important mining enterprises, are under great obligation. As for Mr. James M. Holman, he worthily represents initiative and energy in a county we are apt to consider old-fashioned; the senior partner of Holman Brothers has proved that the Cornishman can be as wide-awake and progressive as the most modern of the captains of industry. These three gentlemen, with their three colleagues, impress the onlooker as men excellently fitted for the administration of a mine. The chairman's speech was to the point, frank and unpretentious, sincere and sensible. He gave the essential facts in a few words: the output had been decreased by the enlistment of 128 employees; the sale of tin had been facilitated by the public spirit of Thomas Bolitho & Sons; the metal market was recovering; the mine itself was not looking well; Dr. Malcolm Maclaren had been consulted on the subject of deeper exploration, as to which the manager, Mr. R. Arthur Thomas, would address the meeting. Mr. Thomas spoke to the shareholders not as gamblers in scrip but as the owners of a mine. As the son of Josiah Thomas and the grandson of Charles Thomas, the two previous managers of Dolcoath, he had all the authority that comes from inherited experience and personal knowledge. There was no cocking of the eye at Throgmorton Street; it was a plain, but interesting, statement, such as a manager makes to the proprietors of a property, and to men easily able to follow the simple technology of a familiar subject. Dr. Maclaren had given a discouraging report, the dominant note of which was the opinion that "the lower limit of profitable ore has been reached in the bottom levels of Dolcoath." We admire the courage of the specialist, and we think it is likely that he will prove correct in his forecast: that the chances of finding important orebodies below the 550-fm. or 3300-ft. level are slight. However, we sympathize also with the man-

ager, familiar with the mine during its many vicissitudes of fortune, and saturated with an experience that is more fundamental than the immediate evidence. It is the case of the medical specialist that is called into consultation with the family physician ; the latter persists in his belief that the patient can be saved, despite the unfavourable diagnosis of the authority ; the local practitioner knows the patient's tough constitution ; he has seen him rally from similar attacks ; he is convinced that there is hope, despite the verdict of the specialist. Mr. Thomas is no crazy optimist ; all he says is that he cannot accept geological opinion as conclusive ; the past history of the mine warrants a further test ; while he would not advise the company to spend the £10,000 necessary to explore 50 fathoms deeper, he considers that the company should spend half that amount if the landlord will agree to furnish the other half of the money required. We trust that the Tehidy estate will do so ; certainly the royalties that it has received from Dolcoath warrant a generous attitude at this crisis. Mr. Thomas's view of the problem—persistence of ore in depth—is summarized by one of the remarks he made at the meeting : "One may theorize about these things, but can never know until one explores." Truly that is the miner's standpoint. We do not find fault with it, especially when expressed by an engineer that has an intimate knowledge of the mine is question. Believing that mines must 'peter out' as surely as men succumb to Anno Domini, we yet conclude that the past vitality of Dolcoath warrants another probe in depth. At the same time, the less developed western ground affords chances of discovery ; and lateral explorations, by cross-cut and drifts, will be made pending the final test. Needless to say, we wish every success to these further searchings for ore, and we hope that while they are in progress a good tin market may tend to prolong the productive life of this splendid old mine.

Antimony.

The great demand for antimony caused by the requirements of war has forced the price to such a high level as to direct the attention of the mining man to a metal that is usually neglected by him. We confess that our pages have seldom, if ever, contained reference to the mining of antimony ores, to metallurgical processes involved in their treatment, or to the industrial uses of the metal and its compounds. Indeed, such mention as has appeared has been in connection with the pestilential influence of stibnite on the extraction of gold from refractory ores. In ordinary times, antimony has a fairly regular consumption, and the smelting of its ores is in comparatively few hands. The supply of ore is greater than the demand, so that an antimony property is attractive neither to the miner nor to the promoter. Thus it is that the subject is seldom discussed. Twenty years ago the metal was sold at £40 per ton, but the price gradually receded owing to sources of ore increasing, and many poorer mines were closed. At the level of £26 to £30 per ton the mining of stibnite was only profitable to those that could smelt their own ores and market their products, or to those that had ore either rich in stibnite or containing a notable proportion of precious metal.

The world's output of antimony is difficult to estimate, owing to the official figures not always differentiating between ore, concentrate, antimony crude, and antimony metal. In Europe the largest producers are France, Austria, Hungary, Sardinia, Servia, Spain, and Portugal. China is undoubtedly the largest individual producer at present, the industry flourishing in the provinces of Hunan and Ssuchuan. Mexico is also an important producer, and it is of interest to note that the outputs of both China and Mexico are to a great extent controlled by the firm of Cookson & Co., of Newcastle-on-Tyne, whose name is indissolubly associated with this metal.

Australian production comes chiefly from Victoria. Algeria sends ore to France. Bolivian resources of stibnite are extensive, though little of the ore is shipped to Europe. Japan used to be a producer, but nowadays draws its supplies from China. The antimony credited to the United States is contained entirely in hard lead, much of which is smelted from Mexican ores. The official figure for the export from China during 1912 was 14,100 tons. The production in Mexico was about 4000 tons, and that of France about 5000 tons, while Hungary produced 900 tons. Probably the output throughout the world is from 30,000 to 35,000 tons per year. The smelting of antimony ores is in the hands of a few firms in England, Cookson & Co., Hallett & Fry, and Johnson, Matthey & Co. being the most important. There are several smelters on the Continent, and the Chinese producers treat their own ores. The largest Chinese company is the Wha Chang. This company has a selling contract with Cookson's, but recently it has opened an independent selling agency at New York, hoping to take advantage of the present high price. The metallurgy of antimony does not present any complex problem. The sulphide, stibnite, is practically the only ore treated, and it can be readily separated from gangue by fusion owing to its low melting point. The concentrated sulphide thus obtained is usually called 'antimony crude,' an illogical term. This is roasted, and the oxide smelted with carbon. In the smelting process it is necessary to keep the molten surface covered with slag, otherwise the metal reoxidizes immediately. On cooling, the surface is found to be starred, and the nature of this starring will indicate to the expert the probable proportion and character of any impurity.

The uses of antimony are manifold. As a metal it is too brittle to be used alone, but it forms with tin and lead a great variety of valuable alloys. If added in the proportion of 10% to tin, it forms an excellent alloy that can be employed as a substitute for silver for ornamental and table uses. This alloy usually contains smaller proportions of other metals, such as copper, zinc, lead, and bismuth, and the trade names for the different variations are numerous, though Britannia metal and pewter are the chief. Another set of alloys of nearly similar constitution are the antifriction metals used for machinery-bearings. The first to employ this alloy was Isaac Babbitt, who recommended the proportion of 67% tin, 22% antimony, and 11% copper. It is interesting to note that Babbitt's invention really consisted in the method of constructing the bearings, and he made no claim to any special alloy. Since his day hundreds of other antifriction metals have been introduced, each claiming successively to be the last word. Of scarcely less importance are the alloys with lead. Ordinary hard lead produced from galena containing an admixture of stibnite has many uses in the arts and industries, especially where acid has to be resisted. Type-metal is a mixture of lead and antimony, with tin usually added. Antimony has the valuable property of causing the lead alloy to expand slightly on solidification, a property of particular value in connection with the casting of type. The success of the linotype machine depended primarily on this property of antimony, for without its aid a sharp casting of a line of type could not be produced. Alloys of lead and antimony are used in the manufacture of cartridge cases and for making shrapnel shot. The chemical compounds of antimony are used in the manufacture of safety-matches, fuses, paints, mordants, vulcanite, and medicines. In the case of safety-matches and fuses it is the artificially prepared sulphide that is used. Oxide of antimony has a limited use as a white paint, which compares favourably with white lead and zinc white, and the oxide and sodium meta-antimonate are used in the manufacture of white enamel. Naples yellow is a lead antimonate, and there are also many other

pigments of various colour made from the oxide and sulphide. Pottery manufacturers employ these pigments extensively. Trichloride of antimony is used for bronzing objects of copper and iron, and plaster of paris images can be coated by the same means. Pentasulphide of antimony is used for vulcanizing rubber, and several organic salts are valuable as mordants. In medicine, tartar emetic is well known, and a preparation of the sulphide is employed in veterinary practice. When we hear of antimonial poisoning we usually suspect the person that has access to the medicines of the stable. As regards the distribution and consumption of antimony and its compounds, the alloys are made in all the industrial countries, and the compounds chiefly in Germany. Of the combatants in the war, Russia is the only one to be inconvenienced by shortness of supply, and it is chiefly owing to her extra needs that the price has been rushed from £30 to £70 per ton.

Banks.

In financial circles a stricter definition of the word 'bank' is required, just as among mining engineers it is desirable that valueless rock shall not be allowed to masquerade as 'ore.' From time to time agitations have arisen with the object of impressing the Government with the necessity of protecting the public against unprincipled adventurers who hide their designs behind this word. Five years ago we called attention to the subject. Since that time ten so-called banks have come under the notice of the courts in one way or another, and either their insolvency or their indifferent character has been exposed. Many of these had been formed by men of no financial resources who offered high interest for deposits and employed the funds thus obtained in money-lending transactions of the shadier type. The customary definition of the word, both etymologically and by current usage, is an institution where money can be deposited for convenience and safety, and where money can be borrowed on equitable terms for legitimate purposes. The shorter definition omits the qualifying adjectives and clauses, and can thus be made to cover any scheme that attracts lenders and borrowers. Of course, the fuller definition could not be employed legally, for it is impossible to give effect to the qualifying words. But the promoter could be required to give a substantial guarantee that would be a practical equivalent to the verbal assumption of good faith. This is the policy in connection with insurance companies and railways, both of which are required to file their accounts in an approved form. Moreover, the insurance companies are obliged to deposit a large sum of money with the Board of Trade before commencing operations in order to prove their ability to meet the early claims. Similar requirements might be demanded of promoters of banks, for the disclosure of the possession of £250,000 and its application in the business would prove the legitimacy of the proposition. Nowadays the banks serve an additional function, besides offering facilities to lenders and borrowers; for, by the growth and ramifications of the system of payment by cheques, the banks have become the collectors of debts and payers of accounts on behalf of the community. The Clearing-House, an association of bankers, affords the facilities for settling the daily transactions in cheques. This institution offers an opportunity for restricting the use of the word, for it is obvious that no 'bank' could hope for admission to membership of the Clearing-House, or for affiliation for Clearing-House purposes with some member, if it did not command the respect and confidence of the fraternity generally. In Continental financial circles the word has a wider application than in England, and many businesses that we call 'financial houses' here are known as 'banks' in France. Some years ago the Robinson and Barnato groups founded

banks that were intended to protect their resources, but the scheme did not meet with approval. In France any investment company, even those dealing in speculative investments, such as mines, are customarily called 'banks.' If the same principle were applied in this country, the Central Mining, Consolidated Gold Fields, and the Exploration Company would come within this category. There is, of course, no desire to adopt the French nomenclature, or to ask our French friends to bring their system into line with ours. We only mention the matter to show that in other countries the accepted application of the term is more elastic than here. As regards the necessity for clipping the wings of the needy adventurer and for preventing the use of a word of honourable association for the purposes of the gutter, no one will disagree with the general principle, though there may be differences of opinion as to the details of the necessary reform. But it is clear that the present is hardly the time to push the agitation, for the Government has more important financial problems in hand.

The British Empire.

Among the events consequent upon the Great War none appeals to the imagination or warms the heart so strongly as the instant loyalty of the overseas dominions and colonies of our far-flung empire. According to German writers, England had stolen a march on the other nations and had fenced large portions of the common land of the world for her own possession before the others, especially Germany, were properly awake to the fact. Having been a burglar in her youth, England was now posing as a Sunday-school teacher and advising her neighbours that property rights must be observed by all good people. To the German, the British empire was the product of accident, theft, or ineptitude. We had muddled into our great heritage. We were unfit to retain it. It was Germany alone that was "dowered with the genius for empire." "English imperialism has failed to link the vast empire together, either for purposes of commerce or defence," so they said. A policy of separation was being planned by our dominions. They waited but the chance, of German aggression, to align themselves against the mother country. The nationalist movement in India and Egypt threatened a mutiny, while in South Africa "the Low-German element" promised a disruption of the slender threads of loyalty. Moreover, the Irish were eager to strike at the British tyrant and were ready to place themselves under the kindly heel of Zabern.

The statement of the case is a satire on recent history. The jaundiced eye of a military oligarchy assumed to itself the clearness of prophetic vision. The perverted historians of aggression arrogated to themselves all the qualities they thought lacking in those they intended to attack. The German writers spoke of their "instinct for empire," they prated of their mission to civilize, they claimed a heaven-born right to impose *kultur* over the visible creation. In regard to the German effort to colonize, it is only necessary to quote a German authority, Professor Bonn, of Munich University, who stated, in an address before the Royal Colonial Institute on January 13, 1914: "Apart from South-West Africa, where we [the Germans] solved the native problem by smashing tribal life and by creating a scarcity of labour, we are only just now beginning to understand native administration. Germany from the first has stood for scientific methods in colonization, and with true German arrogance she has applied fixed rules to flexible problems." Colonization to the German means the imposition of rigid regulations by aid of a military caste. It means the "scientific dragooning of natives into a dull comprehension of the meaning of German *kultur*," using the word as a synonym for administration or scheme of

things. On the other hand, the British flag has stood for tolerance, for the philosophy of "live and let live," for giving a chance to the native, for freedom of commerce, for the development of the waste places of the earth, and for the right of self-government.

We need not claim to have been philanthropists; it was the spirit of adventure that sent the energetic sons of our little islands to the far corners of the earth. We need not pose as missionaries; it was the enterprise of a mercantile people that caused us to establish markets all over the seven seas. Our governors and pro-consuls of empire may have builded better than they knew, but they also had a purpose not wholly mercenary. India is our exhibit; Egypt is our witness. The affection of Canada, Australia, and New Zealand is our recompense. The loyalty of South Africa is our proof. What are the facts? When the thunders of war rolled across four continents and England prepared to face a bitter enemy, what did her children do? Did they revolt, as the German professors expected? Did they seize the chance to assert independence, as the Potsdam militarists predicted? No! By St. George and Merrie England! No! The mandatory bugles of Berlin had hardly blown their blustering call before the great rally began in every part of the earth where flies the Union Jack. Offers of men and gifts poured from our kinsmen across the seas. Canada promptly offered 32,000 men and later proceeded to raise 100,000. Australia sent 20,000 and has promised 40,000. New Zealand sent 8000. India came forward in princely fashion; no less than 700 rulers of native states offered their personal services and the resources of their domains to the defence of the Empire; 70,000 troops volunteered at once. Even the Dalai Lama offered 1000 Tibetan soldiers. In South Africa General Louis Botha, lately in command of the Boer armies that had been arrayed against us, but now Premier of the Union of South Africa, said: "The Empire is at war; consequently South Africa is at war with the common enemy." He organized the Union forces and led them into battle himself. Two of his sons volunteered for service. The people of Egypt refused to follow their misdirected ruler, and threw off the Turkish suzerainty in exchange for a British protectorate. Beyond men and munitions of war, the overseas dominions sent gifts without number; for example, flour came from Canada, oats from Alberta, coal from Nova Scotia, horses from Saskatchewan, potatoes from New Brunswick, butter, bacon, and arrowroot from Queensland, maize from Rhodesia, cheese from Quebec, sugar from Barbadoes, Jamaica, Mauritius, and British Guiana. Native chiefs in Bechuanaland, Syrians in New Zealand, residents in the Leeward islands, were among those that sent money. From the pampas of the Argentine came the sons of the Empire to offer service, through the Malayan jungle they hurried to the standard, across the wilderness from Hudson's Bay they tramped eagerly hoping to be not too late. The complete list would tax the geographical knowledge of a Charlottenburg professor and stimulate the imagination of a Patagonian sloth. The expression of loyalty and co-operation was a superbly convincing answer to the question whether the Empire was a vital organism or the mere sham that it had appeared to an astigmatic Junker. The silken threads of loyalty to an idea proved stronger than the steel bands of military coercion. War unified the Empire under the common flag because justice, mutual tolerance, and goodwill had been given free play wherever the map showed the imperial red of Britain. As was said by Sir Wilfred Laurier, the French ex-Premier of a British dominion: "The British Empire stands stronger on a foundation of freedom than the German empire on a basis of blood and iron." Or, as was said also in the Canadian House of Com-

mons, by Mr. Weichel, speaking for Canadians of German origin: "We appreciate to the fullest extent the British laws and institutions, which guarantee us freedom of speech and liberty of conscience." For that guarantee the sons of the Empire stand shoulder to shoulder: men in distant lands, of diverse races, rich and poor, all united under the Flag that is the emblem of a larger tolerance and an ampler perspective. They repudiate the gladiatorial theory of Prussian aggression, the biological necessity expressed in the assassination of Belgium, the Nietzschean dogma that substitutes the 'will to power' for all the slowly gathered ideals of human kindliness; they have drawn their swords to end the truculence of militarism, and, most of all, they have hastened to the battle-front to prove, to the hilt, that the British Empire is no loose aggregation of soulless fragments, but a living unit, one and indissoluble, now, and for ever.

Underground Waters.

In the Précis of Technology last month we gave the gist of an extremely interesting address made by Mr. James F. Kemp, Professor of Geology in Columbia University, to the New York section of the Mining & Metallurgical Society of America. That society, besides acting as a watch-dog on the American Institute, holds local meetings—at New York, Philadelphia, and San Francisco, for example—some of which are distinguished by exceptionally interesting discussions, together with an occasional paper of more than ephemeral importance. Such was the statement made by Professor Kemp under the title of 'The Newer Theories of Ore Deposition.' Pleasantly informal as it may have been, it marks a mile-post in the study of mineral deposits. Tracing the first association between ore deposition and volcanic action from Elie de Beaumont through a long line of later investigators, he recalled how Le Conte and Newberry had built a theory of vein formation on the basis of an upper water-circulation. To these two worthies we owe the idea of a rainfall that percolates into the crust of the earth until it reaches a warmer region, whence it is driven to surface to issue as a thermal spring; in its passage, more particularly in the ascent, this water dissolves minerals, which become precipitated as the temperature and pressure diminish in the approach to surface. This was the idea to which Franz Posepny, in 1893, and C. R. Van Hise, in 1900, gave further dignity. It was the idea of the domestic hot-water system. Posepny elucidated the particular agency of the descending part of the system and gave us the 'vadose' zone. He established the upper limit of the 'ground-water,' but failed to tell us where its lower limit might be. Van Hise, in a paper of rare thoroughness, discussed the downward penetration of water, the extinction of cavities in depth, and the impermeability of rocks under deformation due to pressure. He placed a limit on the scope of the rain-water circulation, but he placed that limit deeper than the evidence of mining will permit. He put it at 10,000 metres, while the testimony of the mining engineer allows a depth of less than 2000 feet for the distribution of this meteoric water. But before Van Hise had gone on record, J. H. L. Vogt, of Christiania, had begun a series of papers suggesting, if not proving, that sundry mineral deposits were precipitated by the gaseous and aqueous emanations from molten magma. J. E. Spurr developed the idea in America, more particularly in connection with his geological investigations at Aspen, in Colorado, and Mercur, in Utah. Then came Kemp, with his 'Rôle of the Igneous Rocks,' before the American Institute in 1901. He insisted on the dryness of deep mines and the limited downward reach of the meteoric waters. These he considered incompetent to have formed the deeper orebodies of the sulphide zone. On the contrary, he imputed their origin to the waters of magmatic or deep-

seated volcanic source. The veteran, Edouard Suess, came forward in 1902 with the proof that the waters issuing at the Carlsbad hot springs were in no way sympathetic with the meteorological charts of the locality. Neither in quantity nor in composition could they be linked with the rain-fall. In 1905 both Waldemar Lindgren and Kemp indicated how the mineral deposits of limestone-porphyry contacts could be explained by magmatic emissions. Finally, and recently, Edwin T. Hodge has made a number of experiments proving that rain-water entering a mine and descending through sulphide orebodies will become an acid solution of iron, zinc, and copper; but in its continued descent, it gradually becomes neutral, precipitating the copper and zinc forthwith, while retaining the iron a little longer: while deeper still it gradually loses the iron also, becomes alkaline, and contains only alkalies and alkaline earths in solution. The part played by the descending water therefore is brief; it is quite inconsistent with the belief that it could form the ore of the deeper workings of mines. For that we must look to the magmatic emissions. Thus a new avenue of research is offered to the economic geologist, and to the mining engineer. Further analyses of mine drainage and of underground flows are urgently required for this purpose. We trust that both geologists and engineers will co-operate in this investigation, which promises to establish the theory of ore deposits on a firm foundation.

A Last Word.

During the past six years we have striven, with almost wearisome iteration, to emphasize two principles of conduct that seemed to us to lie at the very foundation of the integrity of mining as a business. The first has been the trusteeship involved in the relation of the director to shareholders; the second has been the danger of the mining engineer's participation in share-dealings. As to the first, we may have failed to impress the persons chiefly addressed, namely, the directors of public companies, for to them we may have appeared only as a scribe and not as one having authority. But, in regard to the second plea or injunction, we are not despondent of result, for, in that particular matter, we have addressed ourselves to comrades, who are aware that we also have experienced the perplexities and difficulties, the failures and successes, the disappointments and surprises of a mining engineer. To them we have spoken not as a spectator or a professor, but as a fellow-professional man. So now, as a last word, we lay stress once again on the danger to the *moral* of the profession arising from the engineer's participation in the buying and selling of shares. The danger will vary, of course, with the personal equation and with the manner in which such speculation is conducted, but even in cases not subject to criticism there may lurk unsuspected peril. We do not assert that all men are equally or similarly affected. A man of mature years, with an established reputation and an independent fortune, is unlikely to be much, if at all, influenced by the purchase of two or three thousand pounds' worth of shares in a mine with which he is professionally connected; while a young man, with character yet unformed, without capital, and with a salary of a few hundred pounds per annum, is likely to be thrown off his balance by the purchase of £1000 worth of shares. Even the more experienced and more mature man may acquire blocks of shares so large as to warp his judgment; while the unsteady individual, by combining share-dealing with professional advice to a company, may sink into a hopeless morass of questionable conduct. It is not necessary to refer to instances; they might be misapplied; examples will occur to those acquainted with the inner history of mining finance in London. We recall them now with no satisfaction; on the contrary, with chagrin;

for they are among the few signs of delay in the gradual improvement to be recorded in the status of the mining profession. The fact must be faced that the majority of British consulting engineers have their offices within a mile of the Stock Exchange. This physical nearness involves the contagion of speculation. Only a clearly defined code of conduct can insure immunity from the microbes of Throgmorton Street. We attribute the larger part of the avoidable errors made in the appraisement of mines to the warping of judgment by participation in share gambles. Unfortunately the public and its representatives, the directors of companies, cherish the mistaken notion that an engineer's services are enhanced by his becoming a shareholder. We assert that often this event commits him to a bullish attitude, impairs his clearness of vision, and leads to such further speculation as is subversive of sound judgment. Moreover, even if the purchase of shares is made with some regard for the proprieties—after the report has been made, for example—it does not eliminate the allurement, for neither the directors nor the engineer himself may know at what moment the latter decided to buy the shares. The intention to buy them may have coloured his opinions even before the report appeared in print and long before the purchase of the shares themselves. Not even the individual himself can diagnose his motives with accuracy in such a case. The only thing for the engineer to do is to recognize the frailty of humankind and avoid temptation. While the share-holding public, as we have said, may approve of the engineer's participation in speculation, this same public depreciates the character of the profession, on the assumption that engineers do participate in share-dealing. In other words, the profession must not take its code from its clients; it must formulate a code on its own initiative. In a collective way that can be done by the Institution. Indeed that should be its chief purpose. The reading, discussion, and publication of technical papers is being done well by sundry other agencies; such work is a secondary function of the Institution. Its main objective should be to crystallize the code of conduct that guides the honourable members of the profession in its duties to clients and the public. By stiffening the moral backbone of the profession, it will render it easier to be scrupulous and more difficult to be unscrupulous. Of course, many will demur. To make money in mining, some will say, it is necessary to participate in speculation. Some call it investment; but we do not use that word in connection with a wasting asset. To this we reply, that those who possess financial acumen can undoubtedly make more money in this way than in working for fees. It is a proper way of making money, and all that we ask them to do is not to mix two incompatible functions. Let them cease to practice as engineers, and devote their energies to the other, and equally useful, part of the business. But we can say, out of a wide knowledge of professional careers, that the number of engineers endowed with financial genius is small indeed, and that out of every 100 who skate on the thin ice of speculation at least 95 fall through and get a soaking in cold water, with risk of a fatal attack of pneumonia. The game is not worth the candle. Let the profession abstain from it, and be compensated for that abstention: that is, let the engineer demand higher fees because he foregoes the chance to get rich quickly. It will be well worth while for clients, whether individual or companies, to pay a higher fee to the engineers that willingly forego both the temptation and the risk inherent in share-dealing. It is the one way to give the mining profession a status second to none in the wide avocation of engineering. By eliminating this one slippery *descensus Averni* it will be possible to place the profession on the path of progress that leads to unquestioned integrity and unbounded usefulness.

INSTITUTION OF MINING AND METALLURGY.

ANNUAL DINNER.

NO less than 350 members, associates, and student members of the Institution have joined His Majesty's forces. They represent 14% of the total enrolment of a society that can claim more of an international character than any similar British organization. We believe that this percentage represents practically every member not disqualified by age limit or alien nationality, and it does not include a very considerable number of veterans serving in useful capacities in Home Defence. No one is in the humour for dinners or banquets in these critical times, and this annual dinner would not have been held this year had it not been the desire of the many friends of T. A. Rickard to show their appreciation by gathering together on the eve of his departure. The success of the informality of the dinner and the 'get-together' spirit evinced by those present should prove to the council that simple gatherings of this kind are more in favour with the members than the imposing banquets of past years. Mining engineers are the active workers of the greatest of the basic industries, and these yearly feasts should aim to increase their solidarity, which is more likely to be secured by a simple reunion than the sumptuous banquet with an imposing array of titled guests who have no knowledge of the art of mining, and little or no sympathy with the profession.

At no annual dinner has a president been able to present such a record of notable achievements. The new freehold home of the Institution, the granting of the Royal Charter, the flourishing condition of membership, and the excellent financial position were acknowledged in a modest way by Dr. F. H. Hatch, the president, in reply to Sir Robert Hadfield's tribute to the Institution in the first toast of the evening.

Dr. Hatch arose a second time to propose a toast to T. A. Rickard, and in a few graceful phrases expressed the regret felt by the profession that he was to leave. He dwelt upon the service that had been rendered by many suggestions and criticisms, and struck the keynote when he said "we recognize his singleness of purpose and do honour to his ardour for reform." F. H. Hamilton supported the toast in his usual accomplished manner. As a member of a hastily convened committee he presented Mr. Rickard with an address, and stated that two hundred friends had contributed to the purchase of a tangible token of esteem. This would take the form of silver plate, suitably engraved, to be purchased and presented upon his arrival in San Francisco.

In replying Mr. Rickard stated that he would not make a speech but that he would simply talk. The friendly character of the dinner lent itself to informal expressions of this kind. He gave an outline of his career as editor for the past thirteen years which, curiously enough, has been fairly equally divided between New York, San Francisco, and London. Coming to London, he explained, was a sporting venture, as his financial interests in the *Mining Press* of San Francisco were and still remained very large. What with the trouble in Mexico and the reflex of the European war he must needs return to take personal charge of his investment. He expressed satisfaction in hearing it said that his work had served to raise the status of the profession, and he doubted whether he would have heard an expression of this character had he not been on the eve of departure.

We know that the genuine expressions of appreciation will be treasured as a due reward for an untiring and conscientious effort in behalf of his profession. It has been no easy task, and no one who did not sincerely believe what he wrote could have survived five and a half years as editor, and at the end of that period write with the same fresh and spirited style that has always characterized all of his utterances.

The feelings of those assembled were well summarized by Mr. Hamilton when he said: "I suppose there is hardly a man in this room who, at one time or another, has not had occasion to differ from him on some subject, and when we differ from Mr. Rickard we know it. But I am quite sure there is no man here who does not recognize that no word he has ever written has rankled or left a poisoned wound, that no word he has ever uttered has been actuated by any personal or unworthy motive, or by any other desire than to present the truth as he understood it."

E. R.

PERSONAL.

ALEXANDER ANDERSON is serving with the Royal Garrison Artillery.

J. MACKINTOSH BELL has returned from Ontario.

A. A. BOYD has been appointed general superintendent for the Mount Morgan Gold Mining Company.

J. W. BOYLE is here from the Yukon.

W. CLODE BRADDON has received a commission in the Royal 1st Devon Yeomanry.

W. A. CARLYLE has gone to Norway on a periodical visit of inspection.

ALEXANDER COLLEDGE left for Melbourne on March 6, and intends to proceed to Ipoh, Malay States, in June.

W. H. CORBOULD is here from Queensland.

JOHN P. COSGRO is in London from Chile.

H. T. CURTIS has received a commission with the Royal Engineers, London Division.

G. W. EDWARDS has returned from Siberia.

SYDNEY H. HARMAN is with the Durham Light Infantry, now stationed at Nowshera, on the western frontier of India.

LOFTUS HILLS is examining the Hercules and Mount Read ores on behalf of the Tasmanian government with the object of investigating the applicability of the flotation process.

JOSEPH JENNINGS has been elected president of the Cornisb Institute of Engineers.

R. B. LAMB, of Toronto, is in California.

J. G. LAWN has resigned as consulting engineer to the Barnato group, and will become a member of the London advisory committee.

G. G. S. LINDSEY, the president of the Canadian Mining Institute, has left London on his return to Toronto.

W. J. LORING sailed from Yokohama for San Francisco on January 30.

C. G. LUSH has returned from Nigeria.

T. E. MACKENZIE has left for Portugal.

MALCOLM MACLAREN is on his way to Korea.

T. BRUCE MARRIOTT has left for South America, and as the whole of his technical staff are now serving in His Majesty's Forces, arrangements have been made with W. F. A. Thomae to attend to all professional business.

C. ALGERNON MOREING is recovering from an attack of pneumonia, incurred while on a visit to France to see his son Adrian, who is Transport Officer with the Indian troops.

H. G. NICHOLS has received a commission in the Royal Engineers service as inspector of works.

C. T. NICHOLSON left London for Ipoh, Federated Malay States, on February 20. He has been engaged as advisory engineer to Osborne & Chappel for their various dredging interests.

J. MYEROVITCH, of the International Engineering and Trading Company, of Petrograd, passed through London from Petrograd on his way to the United States.

C. H. MUNRO sailed from New York to Colombia on February 17.

JOHN J. PENHALE, of Sherbrooke, Canada, has been made colonel of a Canadian regiment and is now in England.

C. W. PURINGTON has returned from a visit to Boston.

HAROLD RICKARD has returned from Burma to join the Army.

T. A. RICKARD sailed on March 6 for New York, on his way to San Francisco.

R. M. RIORDAN has returned to New York from San Francisco.

WILLIAM RUSSELL sailed by the *Adriatic* for New York.

GEORGE SCHACK-SOMMER, who went from the Tanalyk mine to serve in the Russian army, has distinguished himself greatly in the Carpathian campaign, being promoted and awarded the Cross of St. George.

ROBERT C. STICHT arrived at Sydney on February 13 on his return from America.

HENRY TATHAM has received a commission with the London Electrical Engineers.

ARTHUR E. TAYLOR left Bombay on February 20 on his return from India.

W. E. THOMAS left for Northern Nigeria on February 10.

W. CAWTHORNE UNWIN has been elected president of the Institution of Mechanical Engineers.

ARTHUR R. WEIGALL sails for Korea early in April.

J. L. WALTON started on his return to the Broomassie Mines, West Africa, on March 3.

O. B. WARD is returning to New Guinea to take charge of operations at the mine on Misima island for the Broken Hill Block 10 Company.

MORTON WEBBER has received a commission in the Royal Field Artillery and is now stationed at Exeter.

EUGENE B. WILSON has resigned as editor of *The Colliery Engineer*, published at Scranton, Pennsylvania, and will devote the whole of his time to the business of the International Text-Book Company.

H. C. WOOLMER is here from Russia..

SPECIAL CORRESPONDENCE

TORONTO.

Cobalt.—The continued low price of silver tends to curtail production, which is likely to show a considerable falling off as compared with last year. The effects of power shortage are being seriously felt. The arrangement with the Northern Ontario Light & Power Co. for the closing-down for one week out of every four went into effect on February 1. The cyanide plants generally preferred to close-down for a continuous three weeks, instead of a week at a time, while the water-concentrating plants pursued the other plan. The air-compressing plants are also affected by the shortage, but those companies that have auxiliary steam-plants are running their compressors by steam-power. In many cases companies are utilizing the opportunity of the stoppage for cleaning-up their mills. The Trethewey mill and mine will shortly close-down for an indefinite period owing to the low price of silver, throwing about 100 men out of work. The Nipissing during January mined ore of an estimated net value of $164,194, and shipped bullion from Nipissing and customs ore of an estimated net value of $344,807. Vein No. 64 is now being developed on the 1000-ft. level, which is the deepest working in the Cobalt district. The mine manager estimates the ore reserves on January 1 at over 10,000,000 oz. The company has taken over on option the Wettlaufer property at Kirkland Lake. The Seneca Superior has been drawing heavily on its ore reserve, and the depth of its vein has been reached and its length established, so that its future and that of the Peterson Lake, which depends for revenue entirely on the royalty from the Seneca Superior, is dependent on further discoveries. The construction of the new cyanide plant on the Cobalt Townsite property of the Canadian Mining Corporation is well advanced. It will treat the tailing from the big stamp-mill and also those from the Cobalt Lake mill, the latter being pumped across the end of Cobalt Lake to the plant.

THE CROWN RESERVE MILL, AT COBALT, ONTARIO.

Porcupine.—The reports presented at the annual meeting of the Hollinger, held at Montreal on February 2, were of a most encouraging character, and indicated that the position of the mine had been materially improved during the year. The president, Noah A. Timmins, stated that the treatment of 208,936 tons of ore had resulted in the recovery of $2,688,354 in gold, of which $1,786,679 was gross profit. Deducting $165,621 for depreciation and a subscription of $10,000 to the Patriotic Fund, a net profit of $1,611,058 remained, out of which $1,170,000 was disbursed in dividends, leaving $451,058 to be added to the surplus. The total surplus carried forward was $1,126,743. Expenditures on plant amounted to $305,621. Working costs had been reduced to an average of $4·42 per ton for the year. Underground development had increased the estimated value of developed ore from $11,604,800 to $13,358,420. The report of the general manager, P. A. Robbins, dealing with the results of diamond-drilling, stated that it might with considerable assurance be anticipated that operations could be continued to a depth of 1500 ft. with strong probabilities at greater depth, as nothing had occurred to indicate a limitation of the depth to which the orebodies might persist. The policy of operating the Hollinger, Acme, and Millerton mines by a central shaft and mill, supplied with compressed air from a central plant, was outlined. It will require about 18 months to put this plan in operation, when it is hoped to effect such economies as will reduce the working cost to $3·50 per ton. The Hollinger has shipped an exhibit consisting of 600 lb. of high-grade ore carrying visible gold to the Panama Exposition at San Francisco. The new 10-stamp mill of the Dome Lake, which began running in October, had produced $19,850 up to the end of January. Satisfactory ore-shoots have been found on the 300 and 400-ft. levels, the vein 15 in. wide running from $40 to $100 to the ton. The Rea has paid a dividend of $12,750, being at the rate of 6⅜% out of the profits earned by a 10-stamp amalgamating mill, which cost only $5000 and was regarded as a doubtful experiment. There is no cyanide annex, and only 87% of the gold is recovered, leaving about $1·10 per ton in the tailing for future treatment. The main vein on the Porcupine Crown, which faulted between the 300 and 400-ft. levels, has come in again; it has been proved to a depth of 1000 ft. and opened up for half that depth. The average grade is reported to be $20 per ton. The mill is treating about 125 tons per day. The company is understood to be negotiating for the purchase of the North Thompson property adjoining. The McIntyre has reached the 625-ft. level, and is preparing to drift at that depth. Ore running $15 per ton has been opened up on the 400 and 550-ft. levels. Underground work at the Dome is stated to be meeting with better results, a drift on the 600-ft. level having encountered a higher grade of ore showing visible gold for some distance. The annual report of the Tough Oakes, in the Kirkland Lake district, shows a total operating loss of $74,323 since the mine has been worked, and a deficit of $129,438. The total earnings amount to $142,844. The production includes shipments of 312 tons of high-grade ore of the average value of $350 per ton and 6325 oz. silver, making $74,590, and from the mill has been produced $43,053 from 3493 tons of ore averaging $22·33. The mill was only recovering about 50%, the tailing running $10 to $12 per ton. The ore reserve is estimated at 51,150 tons with a content of about $1,500,000.

Nickel.—Despite the reiterated assurances of the Canadian government and the officials of the International Nickel Co. that every precaution has been taken to prevent the output of the Sudbury nickel mines from reaching Germany, and that the British war authorities are perfectly satisfied that these safeguards are effective, there is a strong under-current of popular opinion in favour of the absolute prohibition of nickel exports to foreign countries. This feeling is reinforced by the 'Made in Canada' sentiment just now in the ascendancy, many who have no belief that Germany is getting any Canadian nickel favouring the idea that Canadian raw materials ought as far as possible to be manufactured into the finished product at home. This view has been strongly urged by several Boards of Trade and other bodies, and is regarded with some favour by the government of Ontario. G. Howard Ferguson, the recently appointed Minister of Mines, has officially announced that a commission will be appointed to consider the whole question, and that, should they report favourably as to the economic practicability of refining the Sudbury nickel in Ontario, the Government will take steps to bring it about. He stated that hitherto the Government had not seen its way to prohibit the export of raw material, as there did not appear to be any known process by which the refining

industry could be successfully conducted in the Province, but that owing to the rapid advance of metallurgical science it might now be found feasible. Canadian commissions as a rule are apt to do their work in a leisurely manner, so that two or three years may elapse before the existing situation is affected by their findings. Meanwhile, those who favour more drastic methods to meet a present emergency are bringing pressure to bear upon the Canadian Parliament to put an embargo on nickel-matte. Last week W. F. MacLean of Toronto, who is the head and front of the movement, moved to introduce a bill prohibiting the exportation of nickel in any form to foreign countries in war-time. Premier Borden raised the objection that as the measure was one affecting trade and commerce, it must be recommended by resolution of the Committee of the Whole. He was sustained by the Speaker, and the bill ruled out of order. A large number of petitions asking for such legislation have been received, and the question will certainly come up later in some form. There is little likelihood, however, that the government will recede from its position, as party discipline will prevent many who sympathize with the movement from supporting it openly.

[We refer to this matter editorially.]

CAMBORNE.

Levant.—At the last meeting of the 'adventurers' in this company, it was announced that the negotiations for a renewal of the lease had not been substantially advanced since August last, when the 'lords' offered to renew for 63 years on the following terms: Royalties as at present, except that when the mine was being worked at a loss, and until subsequent profits wiped out such losses, half dues were to be charged; the company to undertake to spend £5000 on certain development during the first five years of the new lease, and after that to allocate half the profit toward the cost of sinking a new vertical shaft, and in further development work, until £60,000 had been spent. In view of the disappointing result of the extensive development at depth already done, it is easy to understand the hesitancy of the adventurers in accepting such onerous terms. With the object of giving them further time to consider the matter, the lords have agreed to extend the existing lease for an additional twelve months.

The yearly and half-yearly reports (summarized in another column) of the leading mines in the County have recently been issued, and all of them show that with black tin selling for less than £90 per ton, there is little margin of profit.

Dolcoath earned a gross profit of £3383 for the half-year ended December 31, but with depreciation included that figure is reduced to £899. Although the recovery shows an increase of 4·6 lb. per ton, the quantity of ore milled shows a fall of 16%, so that the net result is a reduction in the returns of 17½ tons of tin concentrate. The average price realized was also down £8. 15s. per ton, and the working cost, excluding depreciation, up 8½d. per ton, and this in spite of the fact that the development was reduced from 3285 to 1051 ft. The most disquieting feature of the report is the disclosure of the opinion of Dr. Malcolm Maclaren (who recently made a geological examination) that the future prospects in the bottom of the mine, in the central and eastern portions, are unfavourable. It is true that the manager, R. Arthur Thomas, is not in agreement with this view, but Cornish geologists whom I have questioned do not seem surprised at Dr. Maclaren's condemnation, and are of the opinion that the developments at these points all go to prove the pinching-out of the orebody in depth. However, the Dolcoath sett covers a large area of mineralized country, and there are many chances in other directions if extensive lateral development is undertaken.

East Pool.—It is heartening to turn from the report of Dolcoath to that of East Pool & Agar, a property now managed by Bewick, Moreing & Co. Here, as has previously been reported in these columns, an entirely new orebody is being opened-up north of the existing workings, the developments on which point to it being a find of great value. The lode has been cut through for 30-ft. without the foot-wall being found, the driving of the cross-cut being suspended temporarily owing to the heavy flow of water encountered. Drifts east and west on this lode average, for the distances driven, over 70 lb. of black tin per ton for a width of 5 ft. exposed. When it is remembered that the average yield of the ore milled at this mine for the year ended December 31 last was only 17·6 lb. black tin per ton and that the total working cost, including all development, was 17s. 9d. per ton, it will be seen how important an effect this discovery, if maintained, will have on the future of the company. The report, accompanied by a plan showing the developments for the past year, is presented in a form that might well be copied with advantage by some of the other leading Cornish companies. The quantity of ore milled

was 81,593 tons, which shows an average duty of 26·5 tons per day for each Holman stamp. The yield was 644 tons of black tin, 108 tons of wolfram concentrate, 456 tons of crude arsenic, and 20 tons of copper concentrate, the monetary value of the whole being 17s. 2d. per ton milled. The average chemical assay of the ore was 15·8 lb. metallic tin per ton, and the tailing averaged 4·68 lb. metallic tin per ton. The theoretical extraction was 70·3% and the actual 70·9%. Attention is again directed to the irregular attendance of the miners, the lost shifts amounting to as much as 62 per day on a basis of 308 full working days during the year. The profit and loss account for the year shows an adverse balance of £95, but it should be noted that £2000 of the expenditure on development was charged to capital account.

Grenville.—This mine was worked at a loss of £3577 for the half-year ended December 31. The chief features of the report are (1) an increase in the tonnage milled of 3032 tons, (2) a decrease in the recovery of 1 lb. of black tin per ton, and (3) a drop in the price realized of £10 per ton of black tin. The working cost figures at 28s. per ton, exclusive of depreciation, and no royalty was payable as no profit was made. The development only averages 1 ft. for every 25 tons milled, which is certainly insufficient for such a bunchy mine. The extraordinary explanation is made that the reduced development is partly due to the employment of rock-drills in sinking Fortescue's shaft; possibly the meaning is that these rock-drills were withdrawn from other development points. The principal shoot is now being developed on the 375-fm. level west of Fortescue's shaft, and if the tin content is equal to that in the higher level, a good piece of stoping ground should shortly be available, which should substantially improve the returns. Captain Battens' anticipation that development to the east of Goold's shaft at the 220-fm. level would be remunerative has proved correct, for a valuable block of ore—the best found in Goold's section of the mine for a considerable time—has been developed. The bold policy of the directors in stocking a substantial part of the mine's production in the early months of the war, when prices were abnormally depressed, proved a success, and this stock is now being sold at higher prices.

Carn Brea & Tincroft.—In spite of a £9 drop in the price realized for the company's output of tin, the loss for the six months ended December 31 was only £284, exclusive of depreciation, as compared with £4832 for the previous half-year. As £260 extra was spent in allowances for employees on active service, this result is distinctly encouraging. The quantity of ore milled was 423 tons less, and the average recovery was less by 1 lb. per ton. The reduction in the loss was due to the lower working cost which was less by 3s. 4d. per ton. This substantial saving was no doubt partly due to the smaller development programme, 1145 ft. being done as compared with 2009 ft. for the previous half-year. As this equals only 1 ft. for every 26 tons milled, it is clear that with a higher price for tin, a more vigorous development policy must be undertaken.

At the meeting of shareholders of Carn Brea & Tincroft, held on March 2, Mr. John Gilbert seconded the resolution to adopt the report and accounts, and he made two announcements of more than usual importance. Mr. Gilbert is agent for Lord Clifden, who owns the mineral rights at this mine, and he and his chief have already done great service in improving the methods of working the properties, concentrating the ore raised, and supplying the necessary capital therefor. The first announcement referred to the keen desire of Lord Clifden to do everything possible to help inventors to increase the recovery of cassiterite from the ore. With this object in view, arrangements have been made to try Mr. Morley Martin's concentrating table, on which a specially prepared surface is used, as described in my letter last month. Whether the table fills the inventor's claim or otherwise remains to be proved, but Lord Clifden's offer to bear the cost of fully testing the table is acceptable and commendable. The second subject mentioned by Mr. Gilbert was the difficulty between the mines and smelters, as regards the price paid for tin concentrate. He gave figures to show that the bids for concentrate by Cornish smelters at the ticketings were unfavourable to the mines, and that sales by private contract with Liverpool firms gave more satisfactory results to the sellers. When the ticketings were established 30 years ago, there was genuine competition among the nine smelters then in existence. The position has been altered recently by the closing of Bolitho's smelter at Penzance, and by the withdrawal of Williams, Harvey & Co. from the ticketings, leaving only three firms to compete. Mr. Gilbert said it was high time the Cornish mines combined to establish a smelter to treat their own ores. In replying to Mr. Gilbert, Mr. J. H. Bain said that his firm would gladly

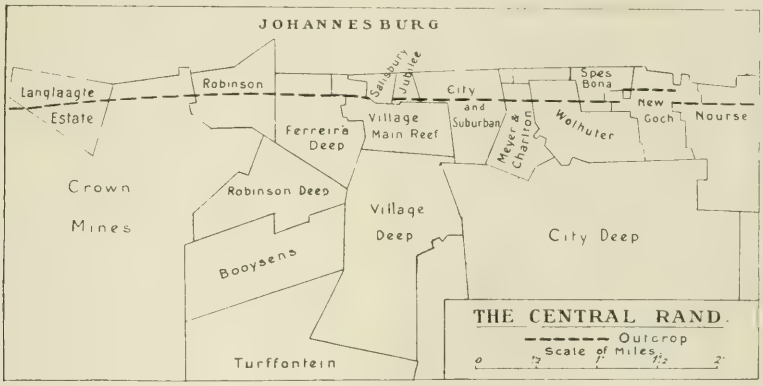
combine with the mines on a co-operative plan to smelt the whole production, and to publish the accounts. The other two tin smelters in Cornwall are in the control of London firms, whose ultimate interests are not disclosed.

A receiver has been appointed for the Schiff group of mines, which includes West Kitty Mines Ltd., St. Agnes Consolidated Mines Ltd., St. Ives Consolidated Mines Ltd., and the British Radium Corporation Ltd. The capitalization of these companies was such as to preclude their ever becoming dividend payers, and it is to be hoped, if re-organization is now possible, that their capitals will be severely reduced. The West Kitty mine and the Giew section of the St. Ives Consolidated Mines appear to have fair prospects, if further working capital can be raised on reasonable terms.

JOHANNESBURG.

War and Mining Supplies.—When the European war broke out some anxiety was felt locally as to whether the mines would be able to continue work for more than a few months owing to the hold Germany had obtained on the supply of essential supplies, such as cyanide, for example, but all doubts have now been completely removed. It is interesting to notice that, in the latest returns, the November imports are stated as amounting to £47,363 in value as compared with £29,390 for the corresponding period of 1913. Similarly the imports of zinc were valued at £13,688 as compared with £7961 in November 1913. The imports of nitrate, in November last, were valued at £51,912 as against £489 only in the corresponding month of 1913. Prices of mining supplies have naturally advanced since the war began, but no doubt is felt now as to the possibility of keeping the gold mines working.

Crown Mines.—The dividend for last year is 85% in place of the usual 110%, while at the time of the amalgamation in 1910 it was stated that the annual dividend would not fall below 130%. The official explanation of this blighted hope is " that the working profit has fallen short of expectations owing to the yield per ton being lower than that indicated by the estimated value of the ore reserves mined." In other words, the yield at the Crown Mines, like every other mine on the Rand, is declining as greater depth is attained, and a correct explanation of the failure of the profit falling below expectation would be that, despite the huge expenditure of capital in re-



modelling the mines above and below ground, the yield per ton milled has fallen more rapidly than the working cost. There are few authorities on Rand mining who still persist in the view that the Rand banket does not become impoverished in depth, but they number only a few, and today may be regarded as principally connected with the group controlling the Crown Mines. It would not be fair, however, to say that the Crown Mines failure to come up to anticipations is in any way due to the want of recognition of this impoverishment of ore in depth, because the administration of the Crown Mines has spent immense sums with the hope of reducing the working cost, the misfortune being that, despite this huge expenditure of capital and effort, the administration has not been able to lower the working cost to the same proportionate extent as the yield has declined. On the other hand, the administration of the Crown Mines has not been able, in spite of the large capital expenditure incurred since the amalgamation, to keep the mills fully em-

ployed, the capacity being 2½ million tons per annum, while at the time of writing the tonnage milled is only 160,000 tons per month, or 1,920,000 per annum. It is this failure to employ the mills to their full extent, so as to counteract the impoverishment in depth, that has caused such a decline in the profit, and until the mills are fully employed the position will not improve.

It may be interesting to examine closely this question of the decline in yield with depth at the Crown Mines. The company represents an amalgamation of six different properties in 1909, which, prior to that date, had paid in dividends £6,653,566 from an average yield of 38s. 7d. per ton. Before amalgamation in 1904, four of the producing companies had an average yield of 41s. 7d. per ton, which, however, in five years fell to 31s. 10d. per ton. The first six months of the amalgamation showed an average yield of 32s. 8d., while at the present time the yield had fallen to 24s. 6d. per ton, the increased tonnage milled after all the heavy expenditure only amounting to 40,000 tons per month. It may be remembered that Mr. George Webber estimated that the yield north of the dike after the amalgamation would average 29s. 10d. per ton, but as stated before, it had fallen to 24s. 6d., and may fall even lower, so that the Crown Mines affords another striking illustration of the impoverishment with depth so common at other mines on the Rand. There is little or no hope of increasing the yield per ton without adding considerably to the working cost, but, on the other hand, there are indications of a still lower yield as greater depth is attained, and only by milling much larger tonnages will it be possible even to maintain recent profits.

Dividends.—In all branches of mining, except coal, in the Transvaal, the dividends paid last year do not compare favourably with those paid during the preceding year. As regards gold mining, the most common explanation as to the decreased dividends is labour troubles, but the mischief lies, I believe, in other quarters. Last year the dividends from the gold mines of the Rand amounted to £8,035,200, as compared with £8,205,200 for the previous year. If we compare the gold produced during the last two years we find a decline in value last year of one and three-quarter millions, but at the same time practically the same tonnage was crushed by the same mines, so that the same amount of work was done for a million and three-quarters less return. Under these circumstances a lower average yield for the year must be looked for, which it is to be feared will not be compensated by the lower average working cost. Still, considering that 1913 was not a bad dividend year, last year's Rand results must not be treated with scorn, as future years will probably show. Even the outside district mines show a decline from £391,333 in 1913 to £336,029 in 1914, but with the varying character of the lodes worked in these outside districts varying results must be expected.

Coal-mining companies last year did quite as well, on the whole, as during the preceding year, and paid £269,981 in dividends as compared with £269,224 for 1913. This is an average of 10% on the nominal capital involved, the rate varying from 5 to 25%. Considering the small mining risks that prevail in Transvaal coal-mining, this return may be considered fair, but Transvaal collieries are proverbially short-lived, and any individual colliery failing to pay a 10% dividend cannot be regarded as a fair investment.

In base-metal mining last year's results were far from satisfactory, the dividends declared only reaching £49,500, as compared with £96,500 for the year 1913. The Swaziland tin mines paid no dividend whatever, while, owing largely to the war, the Rooiberg and Zaaiplaats tin mines only paid half the usual dividends. The Messina copper mine has not yet reached the dividend-paying stage, and, the funds having become involved in outside speculations by the late controllers, will take some time before the profits become divisible among the shareholders.

Persistence of Ore in Depth. — The paper by Mr. T. A. Rickard on the above subject naturally attracted a good deal of attention locally, and not a little comment. Among those who have given attention to the subject on the Rand and are able to express their opinions freely on the matter, it may seem a good deal like thrashing a dead cat to continue the argument on the Rand, where facts so thoroughly show the decline in gold contents with depth. There are, of course, local variations, but they do not affect the general result. The broad fact that now the outcrop mines have all been opened, and the mining operations extended below the limit of secondary enrichment, it has for years required a larger tonnage to be treated to obtain the same amount of gold, ought to be a sufficient argument to prove the want of continuity of richness in depth. Mining on the Rand is just now reaching that point where non-persistence of rich ore in depth will become more marked every year.

A JOURNEY HOME

Down the Colombian rivers, across to Jamaica, Cuba, and New York, and back to England, the voyage being taken during the early days of the War.

By J. B. RICHARDSON.

ALONG a rain-swept rugged mule-road, 500 miles in the interior of South America, I started my journey from the mine. It was cold and cheerless in the early morning, and the mule was angry at going down the bad road, so that the stop for breakfast and the wait for my travelling companion were more than welcome. A long time after my meal was finished my companion arrived. The sun had come out and driven the rain and mists away. We started for England in the bright hot forenoon, urging our beasts with whip and spur into a clumsy canter.

The trees screened the road and turned it into a shady avenue. The streams were none of them too flooded to cross, so that we travelled quickly to the little wayside house that was to be our first resting-place. As soon as we arrived we were handed a letter in English from a man who had preceded us two or three days before with his wife. The letter told us that both of them were sick, but that they had managed to struggle to the next little inn. Onward we rode, this time as fast as the beasts would move, to find our invalids ill and depressed, though a little recovered since the morning. With cheerfulness and tea we managed to get them along to the pretty little village of Saltillo that marks the half-way to the river-port. Here together we spent a miserable night in the village inn, haunted with mosquitos, frogs, and rats.

Dawn saw us starting again, a cheerful party for the river, but fever put a sharp end to enjoyment, for the woman became delirious before noon and had to be half carried to the next village, where the natives prepared a hammock and labourers were pressed into service as bearers.

Then began a slow and miserable procession lasting right into the night, while the poor sick woman was carried to the port. We took eight hours to cover not many more miles, for the road was bad and the men had never carried a hammock before. My travelling companion made himself the hero of the occasion by dashing into the town for restoratives, and dashing back to meet us.

A scene not soon forgotten was our approach to the river-port in the dark, my companion, a tall man, walking by the hammock, steadying and helping the tired hammock-boys who were limping and stumbling every yard of the badly rutted track, myself behind on a tired patient mule, leading a fresh horse

THE SILENCIO MINE OPERATED BY THE FRONTINO & BOLIVIA COMPANY.

and a vicious *macho* who would fight. The husband had gone ahead to prepare comforts for his wife.

This particular river-port must be one of the hottest and most uncomfortably dirty places in the world; probably it was the original of the ancient joke about owning the lower regions as well, selling the town, and going to live below by preference. I translated this joke to a person in the town; he laughed and was not offended, quite in agreement in fact.

The boat was late, and the two invalids—for the husband became ill again—spent a morning in delirium. When the boat did come,

it was crowded and no cabins were available.

The steamers on the tributaries of the Magdalena are not luxurious. This one was a kind of glorified tin-truck with a large barge at either side that had contained cattle on the journey up-river. The captain and the crew, natives of Barranquilla for the most part, were anxious to get back to that port at the mouth of the Magdalena, as they had not seen it for a month, so we travelled down-stream at full speed night and day on a flooded river. The breeze kept us cool, when it was not cold with the driving rain. I got a touch of fever and did not relish the thought of a night on the open deck with the promise, in the sky, of getting wet through. However, the native captain, a rough looking customer, proved to have a heart of gold and insisted on my taking his cabin for the night, which I spent sick and dizzy, curled up in coats and blankets on the floor, while three old crones sat on the bed sleepily chattering and wanting to look after my comfort the whole night through.

All this time we had been passing banana plantations stretching as far back from the banks as the eye could see. It does not seem surprising that this river-basin supplies most of the world with bananas. Early on the third morning as we neared the estuary, the river widened and the water rippled like a shallow lake. Soon we sighted the houses of Barranquilla, our destination, which we reached after a splendidly rapid trip, well in time for the mail-boat.

It was remarkable to us to see trams, shops, and hotels again, all of which seemed excellent, though heaven knows nobody thinks so going into the country. On account of the sick Englishwoman we decided to go home by a direct route and did not try to catch the mail-boat. For this reason, when we found the steamer that we intended catching had sailed three days before its scheduled time, we were forced to travel home by a roundabout route.

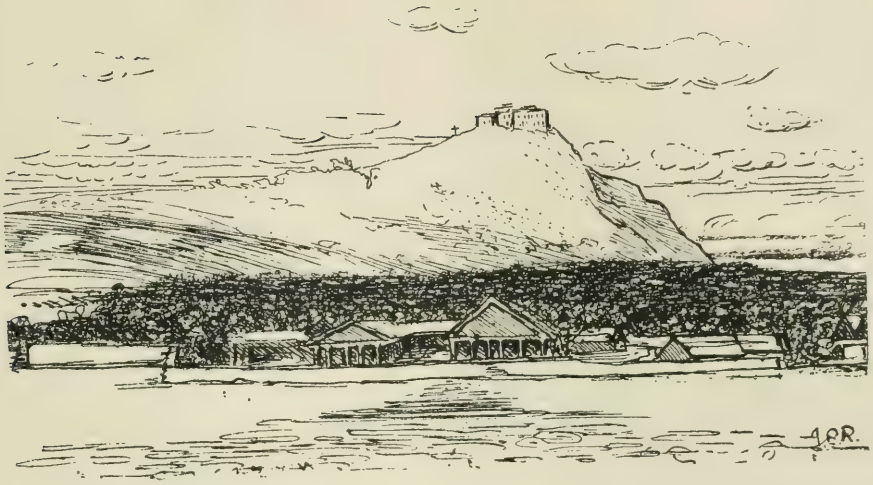
As yet we still had no idea of a war, although the night before we left, the British consul had the news that Austria had declared war on Servia. That evening I went to the home of an English friend who lived with two young Germans and we laughed and chatted over the idea of a general European war, jesting about taking each other prisoners if England and Germany became involved. It was a toss of a coin that decided us to go to New York by a British vessel instead of a Hamburg-Amerika boat. Where we should have been now if we had taken that German liner, I do not like to imagine.

The day after leaving this town of dust, glaring white-washed houses, and bumpy streets, we reached the famous old port of Cartagena, recalling memories of Drake and the good old days when the British navy was little better than a collection of select bands of buccaneers, and Spain was mistress of the seas. We went in by the passage that Drake found when the Spaniards had stopped the main entrance to the harbour with three sunken galleons. On the brow of the cliff overlooking the town still stands the old convent where the nuns flung themselves down the hillside at the approach of Drake's bold brigands.

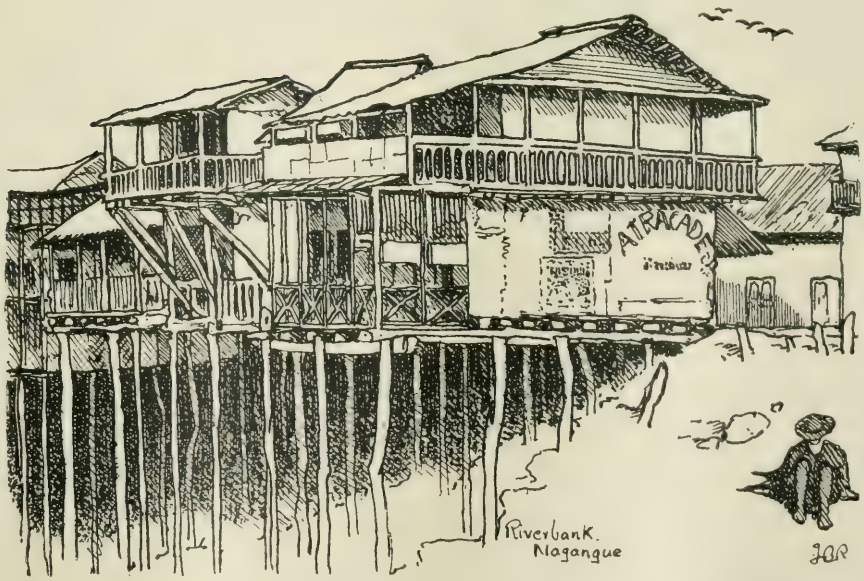
We did not stop many hours before proceeding to Colon at the eastern end of the great canal. As we entered the harbour, we saluted a German liner on her way out. Half an hour after we learnt that we were at war with Germany. Naturally we did not believe it, certainly we did not take it seriously; most of us considered it Yankee exaggeration and were vastly amused at what we took to be the amazing lies of the American yellow press. Later we heard—for we were not allowed to land, and those not in quarantine did not avail themselves of the chance—that at the French and German consulates there were mobilization notices posted. The Marconi man went and got the latest cables, which confirmed the rumours. Some of the foreigners on board at once transferred themselves to other ships sailing direct to Europe. Thus we lost our baker and several cooks.

Still we could not understand. It was like a strong blow in the face, that does not hurt you so much as it makes you silly and dizzy. Everyone said "Wait till we get to Jamaica and then we shall really know the truth." That evening a young German, an officer of the Naval Reserve, burst into tears on hearing that war was declared and exclaimed "Our poor little Navy." He tried hard to get back to Germany, but his consul persuaded him to give up his efforts. We left in Colon harbour five German liners that had orders not to move until the end of hostilities.

On the way to Jamaica the situation was seriously discussed; the ship's officers seemed to think it quite probable that all passengers would be landed there to remain until the end of the war, the boat proceeding to England for transport duties. As soon as we were sighted from Port Royal, our wireless was ordered down and we crept into Kingston harbour a shipful of anxious souls. But there was no news in the Jamaica press, only pom-



CARTAGENA, THE OLD PORT ON THE COAST OF COLOMBIA NOT FAR FROM THE MOUTH OF THE MAGDALENA RIVER.



HOUSES ON THE BANK OF THE MAGDALENA RIVER, COLOMBIA.

pous articles proclaiming that Britannia still ruled the waves. But we were glad to learn that we could proceed to New York, though we realized that the situation was serious indeed, as our course was to be altered and no lights of any kind were to be shown for fear of the German cruisers hanging about the Islands.

Quite leisurely the boat was loaded with bananas, while we spent a day and a half enjoying the wonderful fruit of this British island with only one decent hotel, and that an American enterprise. From Jamaica we proceeded to Cuba, where we called, but gained no news. Turning north on a course more than 50 miles out of the normal, we made full speed for New York, where we knew we should hear all about everything. Everyone was confident of good news. Everyone tried to seem unconcerned, only grumbling at the 'no lights' order that spoilt the evenings, for the smoking-room with stuffed windows was unbearable, and most of the women-folk went to bed directly after dinner. They did show a little anxiety. There were several Germans on board: the barber, a highly intelligent man, who argued well in support of German educational methods, and the ways of bringing up their young men, pointing out how the military system stopped marriages between the young and foolish. A young agent for Krupp's mining machinery in Chile showed me his papers, having started off long before the war to return to Germany, anxious to see his father after several years absence. There was also a large German family returning from Chile to Germany. No one seemed antagonistic to the Germans; in fact, we all tried to make it pleasant for them.

A sigh of heartfelt relief went up when we sighted the Longships and turned into New York harbour. An hour before we had sighted and spoken a British cruiser; so, for these two causes, we were quite light-hearted. The Statue of Liberty and New York harbour are wonderful, but what with the doctor and breakfast, most of the frontage with its giant buildings was seen through portholes.

New York is a wonderful city, but not for the things it is notorious abroad. The Subway is inferior to our Tube system and the Elevated to our Metropolitan, and the trams are in no way superior to the L.C.C. system; but what wonderful vistas looking down and across the avenues with the low-toned silhouette of giant buildings against an evening sky! At some points you cannot look in any direction but that you see a townscape equal to the finest in London. Of course, it is obvious that they had to build these great piles; they could not extend laterally, being on an island, and they could not go down far or they would soon have been under the river-level, so the only possible extension was upward.

At night from the first-storey windows of the newspaper offices large blackboards, each with a couple of busy chalkers, told the latest war news to huge crowds in Broadway—intensely interested crowds that on the surface did not seem to lean particularly either way. There was one little pro-German organ started since the war began that had a tremendous poem on the front page, abusing "the harlot of the nations," the "barbarian hordes," and frankly cursing England, but, paradoxically, it had to be printed in English. The papers, morning and evening, all screamed and shrieked. It was only ten days from the beginning of the war and we learnt that already Germany was buying huge supplies of dogs' flesh; we learnt also that the boat in which we had come north had "dashed through a cordon of foes." There was a hysterical air about the press that was more pathetic than humorous.

We Britons all felt sorry when the German family that had travelled with us, having no choice in the matter, had to take up residence in the United States to wait patiently for the war to end.

Passages to Liverpool were easy to obtain and a day and half later on a White Star liner, with room for 1000 passengers, we started across with only 160 on board. It was a dull passage; no deck lights, stuffy saloons and cabins, and never more than half a dozen congregated in the smoking-room, which was made unbearable with blankets stuffed in each window.

There was a family of French Canadians on board, the men going to join the colours, Madame and the daughter to try and become Red Cross nurses, and the same young German from Chile who had been on the other liner, travelling under an assumed name. He told us that he wanted to get to England to look for work, but he was ill advised by someone who told him to cross under an English name. It is true but strange that this German youth and the French girl should be mutually attracted. The mother and the elder brother grudgingly allowed him to pay attentions, and a little steamer flirtation went on from the second day out. The ship's gossips were much exercised about it, and thought it very sad and romantic.

We had a little daily excitement from the telegrams printed in the ship's paper, but they only served to depress us, and patriotic music raised no enthusiasm.

Full speed ahead through fog and foam soon brought us to Queenstown. There it seemed as though we all woke up; the paper-boy who clambered on board was stormed, and he sold out his few papers in five minutes, his last fetching a shilling; but there was no news in them at all.

We felt safe after Queenstown, and the usual feeling of quiet elation on reaching England again was multiplied many times in us as we steamed into the mouth of the Mersey, past New Brighton front, past the liners in dock, some of them, the fastest, grey-painted, lying ready for the Country's need.

As we drew up to the quay, the most hardened and experienced travellers crowded to the side, but only a few khaki-clad figures with fixed bayonets, and a scanty collection of friends and relatives, were to be seen. While we were looking for something to make us realize that Britain was at war, we were ordered down below to pass the immigration officers. Everyone with a name that sounded at all foreign underwent strict cross-examination; a few were detained; the young German, the hero of the little romance, after he had given his story straightforwardly to the authorities, was told he was to be interned. The poor French girl wept in sympathy and would not be stopped by the black looks of her mother and brothers.

The majority of us soon got permission to land and we were not long in hurrying to the train, where everything seemed as usual. The new paper money was the most exciting discovery we made, that, and the pickets stationed along the line.

Rural England made us almost believe there could be no war, but the answers to our eager questions soon settled all doubts, and the seriousness of the situation slowly sunk into our brains while the train bore us homeward.

The Telephone line between New York and San Francisco was opened on January 25, when President Wilson spoke the inaugural words from Washington. The length of the line is 3400 miles and it contains 1480 tons of copper. Naturally the champions of electrolytic copper claim the credit for this installation on account of its high conductivity, but Pupin's induction loading coil shares part of the glory. The fine iron wire in Pupin's coil is only 0·004 in. diameter.

CANADIAN MINERALS AT THE PANAMA-PACIFIC EXPOSITION

By An Occasional Correspondent.

WHILE Canada is recruiting throughout the Dominion, training troops at Valcartier, and in a hundred ways showing her eagerness to take her full share in the responsibilities of the Empire, there is a band of a dozen men—for the most part disqualified from joining the colours by the age limit—working to advertise Canada's resources and to open new avenues of trade for the time when peaceful pursuits shall have followed those of war. Backed generously by their government, these men have erected the lar-

Zinc-Ore Exhibit.

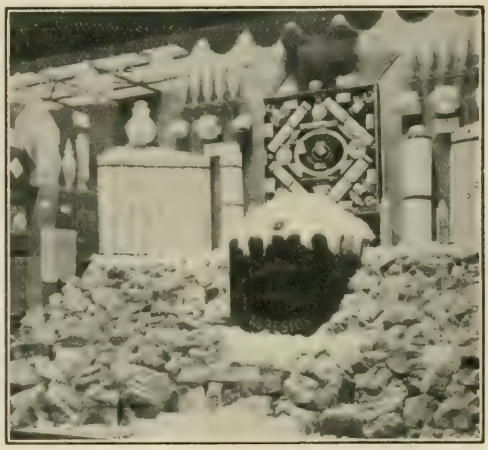
gest and one of the handsomest of the foreign pavilions at the Panama-Pacific International Exposition, and have installed therein an exhibit that will open the eyes of the world to the resources of that vast empire lying to the north of the United States of America.

Except for part of the eastern court, which is devoted to sport, the whole exhibit is a business proposition, intended to show the patent and latent resources of Canada and to lure the honest labourer, the millionaire, and the host that lies between these extremes.

On either side of the central court, there are ten upright show-cases, measuring approximately 10 ft. long, 4 ft. deep, and 9 ft. high, and four larger ones at the ends. In the south court there are two large upright cases, 30 by 4 by 9 ft., and two smaller ones, while the sides of the court are lined with slabs of polished marbles and serpentines, and pedestals and columns of ornamental

stones are dotted about. In these large cases, the minerals are grouped either according to the several metals that are derived from them or to the specific purpose to which they themselves are put, either in the raw or manufactured state, while in the seventy small table-cases that occupy the middle of the central court, the minerals are arranged according to their geographical distribution.

Of the twenty-eight large cases, six are devoted to gold-silver-copper and gold-copper ores, that supply the Granby Consolidated Mining and Smelting Co., of Canada, Ltd., at Great Forks, B.C.—the largest smelter in the British Empire—the British Columbia Copper Co., at Greenwood, B.C.; and the Consolidated Mining and Smelting Co., of Canada, Ltd., at Trail, B.C. Two cases are devoted to silver-lead ores, and in one of them the various stages of anode and cathode development in the process for the electrolytic refining of lead bullion are exhibited. This is of particular interest to those of a metallurgical turn of mind, as the Consolidated Mining and Smelting Co., of Canada, Ltd., introduced and perfected this method of refining lead bullion at their smelter at Trail. Building and ornamental stones, mostly in cubes with one face cut and one polished face, occupy two cases. Here are to be found a beautiful array of granites, marbles, serpentines, gneisses, limestones, and sandstones, together with some curiosities, like sodalite and jasper-conglomerate. If one were asked to single out from this collection a specimen as being more beautiful than its fellows, the homogeneous red granite, from St. George, New Brunswick, would probably be chosen. A magnificent display of Sudbury nickel ores, together with products and by-products extracted from them, and a large diagram illustrating the method of extracting nickel from nickel-copper matte by the Mond process, occupies one of the large cases in the south court. Large placards remind the visitor that Canada provides 70% of the world's nickel supply and that the output in 1913 was valued at $15,000,000. The companion to the nickel case is filled with chrysotile asbestos and products of manufacture — asbestos sheathing, packing, cloth, and many other things. This is another mineral in which Canada leads the world, producing, in 1913, 85% of the supply. Attractive specimens of the famous Cobalt silver ores fill another case. Here native silver can be seen veined through niccolite, smaltite, and chloanthite, while many specimens show the products of alteration of these minerals—annabergite and erythrite. Over 200,000,000 ounces of silver has been taken from Cobalt in the last ten years, and, what is perhaps of even greater appeal to investors, over half of the proceeds of the sale of the silver has been distributed in dividends. Corundum and mica are each given a case, and some well formed crystals of both minerals are exhibited, as are also some very large sheets of mica. Though muscovite mica is found in British Columbia and Nova Scotia, practically the whole of Canada's output comes from Quebec and Ontario, and is the phlogopite variety, a variety that, on account of its



Asbestos Exhibit.

pliableness, finds great favour in electrical trades. Coal occupies one of the big cases in the south court, and is as attractive as a coal display can be made without igniting it. Large specimens are shown from Nova Scotia, the leading coal-producing province of the Dominion, Alberta, British Columbia, and New Brunswick. In the other big case in the south court are to be found the plums of Canada's mineral kingdom — gold nuggets from the Klondyke, some of the fabulously rich ores of Nova Scotia, some splendid gold specimens from Porcupine, a massive piece of native silver from Cobalt that, with its gangue, weighs 450 lb., and several smaller pieces of native silver. The other cases are filled respectively with gold ores, copper ores, silver-zinc ores, iron ores, chrome-iron and manganese ores, iron-ore products, graphite, talc and apatite, clay products, gypsum and felspar, and stibnite, celestite, barite, magnesite, and pyrite grouped together.

The seventy small table-cases, as has been said, offer a geographical arrangement of the economic minerals of Canada.

THE MINING OF ALLUVIAL DEPOSITS. II.

A discussion of the various methods of examination of alluvial deposits and of the operation of power and hand drills.

By NEWTON B. KNOX AND CHARLES S. HALEY.

THE factors discussed in the previous article have an important bearing upon the value of an alluvial property, and limit the choice in the method of working. The examining engineer will carefully consider them all and their relative importance one to another. If it be a hydraulic enterprise, the question of water-supply is paramount; it may be necessary to determine the extent of the available watershed, the annual rain-fall, its flow-off, absorption, and evaporation; also catchment sites, and all data pertaining to ditch-lines. As a survey of this kind runs into considerable money, it is well to delay its undertaking until at least some of the ground has been sampled. In the case of a dredging proposition, the determination of available water-power may be held over in the same way.

In addition to the factors already mentioned, the following points should be investigated: Questions of title, royalty, duty on mining machinery, and the existence of legal obstacles to regular operations.

The determination of the valuable content of the property in question, that is sampling, upon which hinges the crux of the examination, calls for the most painstaking and systematic care on the part of the engineer. He must determine as exactly as possible the tenor of the ground and the yardage available for working.

Gold in gravel exists in two forms: that which, for want of a better name, we call the 'gravel-gold,' which was deposited simultaneously with the gravel, and that known as 'flood-gold.'

SAMPLING BY CHANNELLING IN PERU.

Economically the former is all important, as it forms the chief supply of gold in alluvial deposits. It is usually laid down once for all, and covered by subsequent layers of material. Generally it occurs in well defined bands, or channels, of varying width and thickness. When it occurs coarse, the richest portion is usually found on or near bedrock. Strata of sand are generally barren. Surface soil may contain enough gold to warrant the cost of its removal.

Flood-gold is the bane of the engineer. The majority of cases brought to his notice by the unimitiated, for example, deposits where natives are making a living wage by surface panning, prove on examination to be nothing but barren gravel beneath a thin

film of flood-gold. Economically this form of gold is of small moment. It is usually a finely divided flour or flakes derived either from the attrition of the lighter part of the gravel-gold, or being deposited at the present day by the living stream from quartz veins within the drainage area. It is of a vagrant nature, and migrates with each seasonal flood. It is found concentrated on heads of islands or bars, and entangled in the vegetation covering the flood-plane. It is purely superficial, and never attains any concentration in depth.

The gold in the rivers of Europe is usually of this character; notably in Hungary, where the peasants, after clearing-up the river carefully, can depend upon a new 'crop' of gold in the succeeding year. Here the rivers, whether worked or not, show no augmentation of the gold from year to year by reason of these 'crops.' The rivers of Spain are also notorious for this character of gold, as also are many rivers in tropical countries. Deposits capped with flood-gold may or may not contain gravel-gold beneath; therefore its presence is no criterion of concentration in depth.

Sampling by Channelling.—High banks of gravel, suitable for hydraulicking, can sometimes be sampled by channelling their surface after the manner in which veins are sampled. Usually the bank is divided into panels of one or two hundred feet wide. After cleaning the face, a cut is commenced as near bedrock as possible, and extended up to about 5 feet. This cut is conveniently about a foot wide and about 6 inches deep. Exact measurements should be taken of the length and breadth and depth of the cut in several places, and the cubic contents of the sample in place carefully determined. Material from the cut should be measured loose, and carefully washed in a rocker; the gold is then amalgamated, parted, and weighed, and the value per cubic yard, based on the volume in place, is computed.

Commencing at the level of the top of the first cut, another sample should be begun and the operation repeated as far up as possible. It is not necessary that all the divisions of any one sample be in the same vertical line. They may be 'staggered' to suit convenience. By this method the exposed surface of a cliff of gravel can be systematically sampled; greater facility being afforded if old tailing is heaped at the base. This method gives accurate results. During an examination of this character in Peru last year, we had occasion to check certain cuts by re-sampling, and it was found that the yield checked almost exactly. To determine the gold content of the gravel at any distance back from the face, and also the pitch of the bedrock, either shaft-sinking or drilling must be employed.

Sampling by Bulk.—Formerly, in California, it was the practice to sample a deposit by first installing a small hydraulic plant for the purpose of washing a portion of it. If the clean-up was satisfactory, the property was approved. This method has, happily, fallen into disuse, because it gives misleading results. It gives a large sample from one place, which may or may not be representative of the whole deposit. A case is known to us where $1100 taken out by the experimental giant on a run of a few hundred cubic yards was subsequently only equalled by a whole season's working of 200,000 cubic yards.

Small dredges have sometimes been employed to test dredging-ground, especially in New Zealand. Where funds are available, this method gives most satisfactory results, but is bound to be expensive in first cost. Subsequent expense may be offset by the clean-ups.

Weighing Gravel.—It is difficult, if not impossible, to determine the amount of the sample taken in gravel that is not firm enough to stand when channelled. In sampling gravel of this character, the sample should be weighed and its volume in place calculated. Before commencing to sample, either by pits or channelling, a deposit of gravel of this character, several trial-tests should be made in order to determine the weight of a cubic yard of gravel in place. The amount of water in these tests should, as nearly as possible, correspond with that in the subsequent samples.

Pitting or Shaft-sinking.—Of all the methods of testing alluvial ground, that by means of pitting, or shaft-sinking, is the most reliable. We would not consider any alluvial ground properly and finally tested without the sinking of at least a few shafts. As will be pointed out later, drilling, in our estimation, is only a makeshift, the value of which, aside from preliminary testing, is dependent upon checking by shafts.

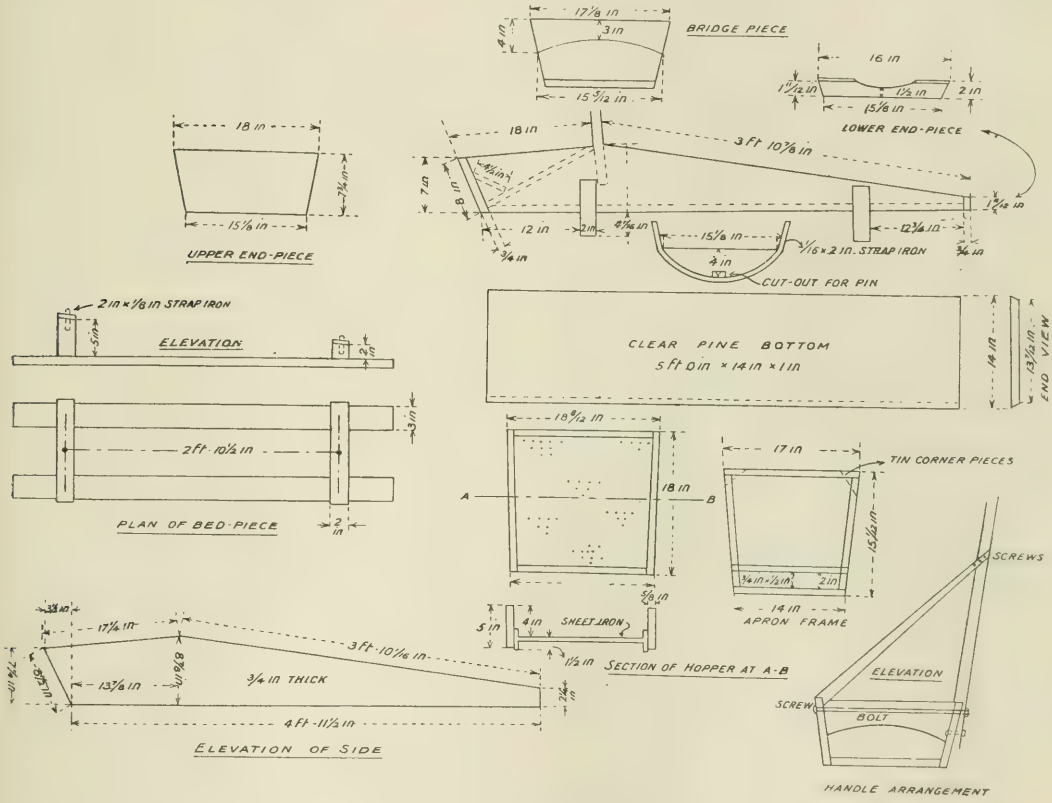
In order to save the handling of excessive material, and to keep down the cost, the shaft should be as small as possible. In California, where the ground does not have to be timbered, a size of 2 ft. 3 in. by 4 ft. is often employed. This gives one cubic yard of material to every three feet of depth. Where convenient, all of the material is put through a rocker. Sometimes channels are cut down

the sides and the gravel from the measured cuts is washed. It is hardly necessary to state that gravel taken from cuts should not be quartered down, or 'coned,' as in vein-sampling, for the gold will be concentrated by each re-handling, and erroneous results obtained.

We give herewith the working drawing of a rocker that we have used with excellent results in prospecting ground. Most rockers, the designs of which have been published, are too high and too short, and consequently are not good savers of fine gold.

Sampling wet ground by shaft requires great care, since the continual pumping of the water forms channels that wash the gold from territory outside the limits of the shaft, thereby producing an enrichment. To mention one of the difficulties attendant upon sampling in wet shafts, one of the present writers had occasion to inspect a tin-dredging property in Cornwall. Here the dredge was only recovering about half the tin indicated by the shafts. It was found subsequently, in following each successive step of sampling, that the shafts were sunk in material containing a large proportion of barren slime. In draining the shaft, these had been pumped off, and only the richer and now concentrated sand left on the dump, which was sampled as being representative.

The cost of shaft-sinking, compared with that of drilling, is high. Nevertheless, this high cost is justifiable in consideration of increased confidence in the accuracy of the results obtained. A shaft not only determines the value of the gravel, but the character of the ground can be determined in much greater detail than in the case of the drill. Boulders lying in loose gravel, often missed by the drill, are exposed. Bedrock can also be cleaned and its character ascertained.



DETAILS OF ROCKER.

Power-Drills.—Almost all of the dredging grounds in California have been tested both before the erection of dredges, and afterward, as a guide to operation, by the Keystone No. 3 traction-drill. This drill uses a 6-inch casing and is operated by steam. It weighs about

6 tons, and costs, with all tools complete, a trifle over £400. It operates a string of tools on a cable attached to a drum, the tools being raised by the pressure of a walking-beam, and dropped by gravity. The drill and stem weigh about 800 lb. The crushed core is removed from the casing by means of a sand-pump of the vacuum type, raised and lowered by an independent reel and cable. The present-day practice in drilling with this machine is to drive the casing one or two feet by means of a driving-block clamped on the drill-stem; then by means of the drill to crush the material forced into the pipe, and pump it out, leaving a core depending on the character of the gravel. This core should be of such thickness as to prevent an inrush of material from below; and yet it should not be thick enough to form a plug that will force away gravel from the casing when driving is continued. The material from the pump is collected in a box, where it should be measured, and carefully panned or rocked afterward. The amount of core that has been pumped from the pipe is recorded in the log, and also the number and size of the 'colours,' or specks of gold, as well as the character of the ground.

In California gold is usually classified in three different sizes: the finest (No. 3), weight about 1 milligramme. Those running from 1 to 5 mg. are classed as No. 2; over 5 mg. as No. 1. The fine colours are usually aggregated and grouped as No. 3. This method of recording the approximate value of the various pumpings enables the engineer definitely to locate his 'pay-streaks.' In Alaska, a different classification is used, namely, No. 1, 2, 3, and nuggets; No. 3 is 1 mg.; No. 2 is 4 mg. and No. 1 is 8 mg., while colours above 10 mg. are called 'nuggets.' W. H. Radford uses four classes: specks, fine, medium, and large.

After the hole has reached bedrock (into which it should penetrate), the casing is pulled by means of what is called a 'pulling-cap.' A cap screwed on the top of the upper casing is hammered upward by means of a heavy steel bar, which passes through the cap within the pipe, and is operated by the walking-beam and cable. The operation of pulling pipe in the Keystone is sometimes serious, consuming a good deal of time and occasionally resulting in loss of casing, due to the stripping of threads.

In drilling with the Keystone, it is not considered good practice to drill below the casing, for particles of gold lodging beneath loose flat rocks, even outside the area of the bore, are shaken down into the pocket formed by the drill and subsequently taken up by the sand-pump. On the other hand, it is not good practice to have too thick a core in the pipe, as there is then a tendency to force material to the side of the path of the descending casing-material, which rightly belongs in the core. With the Keystone, this usually only happens in light running ground. As a general rule the tendency of the Keystone is toward an excess of core.

Calculations. — Employing the outside diameter of the casing as a basis for calculating the volume, has been found in practice to give high results. A pipe formula reducing the value of these results, and based on check shaft-tests made by W. H. Radford, has been generally accepted as accurate. This formula reduces the results obtained by the theoretical formula about 14½%. In its simplest form, it is as follows:

$$\text{Value of gravel per cu. yd.} = \frac{\text{Value of gold obtained}}{\text{Depth of hole in feet.}} \times 100$$

It has been stated already that the Keystone is apt to extract an excessive core. In order to correct this excess, the value of the gold is reduced proportionally by the ratio of the number of inches driven in the 'pay-streak' to the number of inches in the excessive core. When the excess is in barren material, no correction need be made.

Owing to the fact that the casing remains stationary during pumping, excess core can be accurately measured in the Keystone. In this respect it differs from the Banka hand-drill, as will be shown later.

Reliability of Keystone.—At Oroville, California, the Keystone drill has been employed for so many years, and so much of the ground tested by it has been subsequently dredged, that it is possible to determine within narrow limits the ratio between actual dredge-recovery and averages indicated by drilling. Where drilling has been carefully done, 75 to 80% of the estimated yield can be recovered by the dredge. This includes all losses; not only those in the tailing, but unrecoverable islands and corners left behind in the course of operations. In Alaska, however, where the ground is shallow, the gold coarse, and on a shattered bedrock, dredging results have usually exceeded the estimated yield, the percentage of recovery being from 103 to 198. When these high recoveries have been obtained, the dredging depth has always been greater than the drilled depth, in cases by as much as 30 to 40 per cent.

Alluvial gold is found occurring under such widely different conditions, conditions that

affect both drilling and dredging alike, that no arbitrary factor can be applied in estimating the yield of a deposit from the results obtained by drilling. In general, the choice of any discount factor must be guided by experience. Special conditions govern each case, such as the fineness of the gold, the proportion of clay, the number of boulders, the method by which the deposit is to be worked, and, finally, the personal equation of the drilling-crew.

Hand-Drills. — The need of a portable drill in testing alluvial ground has led to the adoption of several types of drills operated by hand, some of which are patterned after the well-digger's tools. One of us had occasion to test a dredging property, in Korea, that consisted of fine gravel about 20 ft. deep, resting on a soft clay bedrock. The gold was concentrated in a narrow streak from 6 to 12 inches thick, resting upon the bedrock. There being no drills available, one had to be devised on the spot. Attempts were made to drill by following the Keystone method, that is, to drive the pipe, break the core, and pump, but this had to be abandoned owing to the ineffectiveness of the home-made pump. The following method was finally adopted:

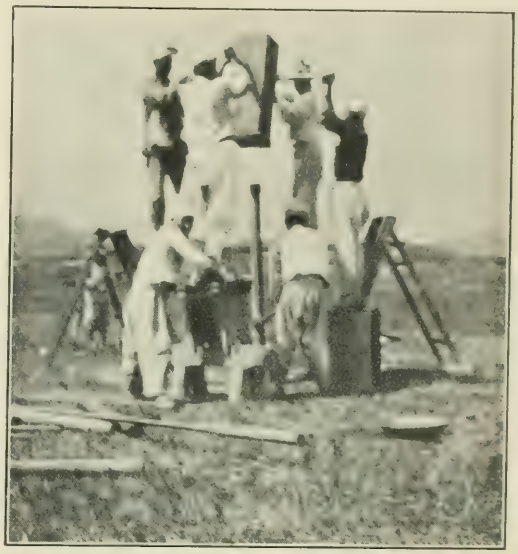
Holes were bored in the overburden by means of an auger to a depth of five or six feet, and a $3\frac{1}{2}$-in. pipe (the only size available) was inserted. This pipe was shod with a sleeve. A sleeve sawed in half, and screwed on top, served as a driving cap. The pipe was driven into the ground with a wooden driving-block operated by coolies standing upon a movable platform supported by ladders. While being driven, the pipe was rotated by means of wooden clamps or chain tongs. No attempt was made to pump out the core. The pipe was driven into the bedrock to a depth of about two feet, after which it was pulled by means of a wooden tripod and chain-blocks, or block and tackle, the pipe being rotated during pulling.

The material was then removed from the pipe by means of a long cork-screw auger. Occasionally the pipe picked up a boulder in its descent, when the hole had to be abandoned and another started. Otherwise the drill worked satisfactorily. About 175 holes were put down by this means, which gave a fair value to the ground. The owners of the property afterward had it re-drilled with a machine of the Banka type, and the result of 200 holes tallied almost exactly with the home-made drill.

It is recognized that this method of drilling can only be adopted under special conditions, and the idea is not claimed as original, it having been employed, with slight modifications, in China.

*__Alaskan Hand-Drill.__—This is a drill devised to meet peculiar conditions in Alaska, where it has been used with considerable success. There labour is efficient, but expensive, and the gravel shallow, being usually much under 20 ft. deep.

This method of drilling represents the successful adaptation of the Korean method, already mentioned as having failed owing to a poor pump. It employs the Keystone method



Driving Home-made drill in Korea.

of drilling, but in this case man-power is used to raise and lower the tools, instead of steam.

Casings of 4, 5, and 6 in. diam. have been tried, but the 5-in. is the one now usually employed. Old Keystone casings are used. A tripod of 4 by 4 timbers, each 16 ft. long, is erected over the hole. From this is suspended a pulley, through which runs a $\frac{3}{4}$ in. hemp rope. Two men on this rope raise and lower the tools. These two men and a panner, who assists them in drilling, furnish all the labour necessary to operate the drill. The driving is done by striking the cap with blocks clamped on the bit, which is a piece of steel 4 ft. long and $2\frac{1}{2}$ in. diam., weighing from 125 to 175 lb. Twenty 2 to 3-ft. strokes per minute is the rate of ordinary driving. When the drill has been driven a foot, the core is measured with

*This description of the Alaskan drill is based on one appearing in the graduating thesis on 'The Prospecting of Placers' by W. H. Sirdevan of Yale University.

a stick, then broken up by the bit, from which the driving-blocks have been unclamped, pumped out, and whatever core left in the pipe measured. The core that has been removed by the pump should be measured in the box, and the volume compared with the theoretical core. This method is fully described later under hand-drills of Banka type. The same correction of excessive cores from the pay-streaks, mentioned under hand-drills, should be applied here. This drill has given excellent results in Alaska, and for shallow gravels where labour is expensive and roads are lacking, it can be employed to advantage. Owing to the greater weight of the bit, it can be used to drill stiffer and heavier ground than drills of the Banka type. Its employment has been limited to grounds of shallow depth, which is doubtless due to the fact that unrotated pipe is difficult to drive and it has been found impracticable to pull pipe driven in this manner to over 20 ft. in depth. It is our opinion that by the use of a turning device, whereby the casing is turned while driving, and also by adopting casing with flush joints, this difficulty of pulling and driving can be lessened and drills of this type used for drilling deeper ground. Doubtless this turning would call for an extra man, but his wages would be compensated by the time saved and by the fact that a depth of gravel of over 20 ft. could be drilled. In Korea it has been our experience that not only could a turned casing be drawn in about one-third less time than one not turned, but the drilling itself was faster. It might be here mentioned that we also found that there was no difference in speed in drilling whether using a shoe with teeth or one without. In the former case the teeth soon wore or broke.

In Alaska the record of 500 holes sunk by means of the Alaskan drill shows that 14% of the time was taken in pulling. In our work with the Empire, 5% only of the time was used in pulling. The speed of drilling in Alaska in shallow ground averages about 20 ft. per day, which includes shifting and pulling. The cost there was about 8s. per foot.

Hand-Drill of the Banka Type.—The most popular form of hand-drill, that known as the Banka type, was invented by a Dutch engineer of the name of J. P. Akkeringa, for the purpose of testing tin deposits in the Dutch East Indies, in the year 1858. It is at present manufactured by a Haarlem firm under the name of the Banka drill, and, with modifications, by a New York concern, under the name of the Empire drill.

The form usually employed is that of a 4-inch flush-jointed casing, shod with a steel-toothed cutting-shoe. A platform, upon which four men can stand while operating the string of tools, is attached to the top of the casing. The various tools used in drilling or pumping are raised and lowered by means of a steel rod one inch square, which is jointed in lengths corresponding with the lengths of casing, usually five feet.

The platform and the casing are rotated by either man or horse. The theory is that the pipe sinks under the combined weight of the men and tools, aided by the cutting action of the revolving shoe, which, in sinking, is claimed to cut a core representative of the gravel passed through.

Much has been written in various technical papers of late in regard to the performance and operation of this drill; and especially in the pamphlets issued by its American makers, its so-called revolutionary features have been emphasized. It is proposed here to give briefly the results of our experience with this drill, based on the testing of various deposits.

Be it said that our results were not always in accordance with the claims put forward in the pamphlets above mentioned; furthermore, we have encountered difficulties that were either minimized or failed entirely of mention in those pamphlets.

The chief point on which we find ourselves at variance, from the results of our own experience, is the method of sinking. As we have already stated, the makers claim that the drill will sink largely by rotation alone. We have attempted, in gravels of differing character, to sink by this method, and have kept a careful record of the cores obtained, our results having been as follows:

First: In ground containing any quantity of gravel having the size of one's fist or over, no progress whatever was made by pure rotation, and eventually driving had to be employed.

Second: In ground consisting mainly of fine gravel, no progress was made until the pump had reached the bottom of the casing, when, while pumping with little or no core, sinking proceeded with fair rapidity. On measuring the core obtained, it was found to be excessive; hence it was observed that good progress could only be made by rotation when the material was pumped away from under the shoe, a process that, of course, gives excessive cores.

We have found that we could secure the best progress in sinking, consistent with the

obtaining of an accurate core, by driving with the battering ram approximately a foot at a time. The ram should not be too heavy. We obtained better cores with a light ram than with one weighing 200 pounds.

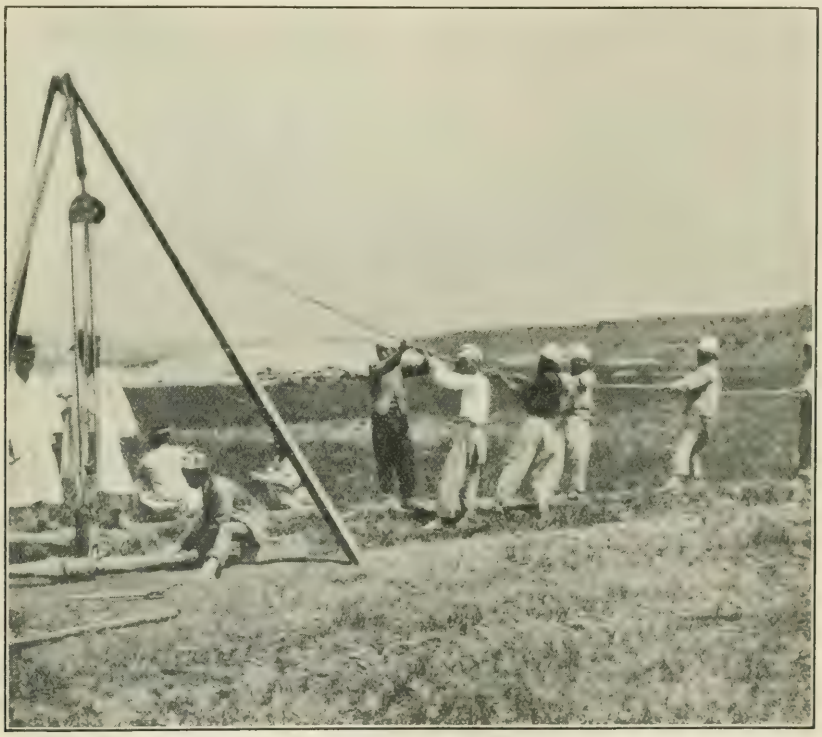
It has also been claimed "that when running ground is encountered with the rotated pipe, there is much less danger of getting an incorrect sample, because the rotated pipe immediately sinks through the gravel till it strikes solid material." We have never noticed this tendency, and the presence of running ground has made itself felt by an influx into the pipe; and while sinking to more solid material, we have always picked up excess core.

One of the weak features of this drill is the method of removing the core from the pipe (namely, with a ball-valve pump). In breaking gravel of any size within the pipe either by means of the pump or the ordinary breaking-bit, a certain amount of the core is always driven out of the casing and lost; which results in a deficient core. In shallow gravel this tendency is more marked than in holes of over 20 ft. deep.

Another cause of deficient core is the peculiar shape assumed by a worn shoe. In contrast with the Keystone shoe (which is bevelled toward the outside, and tends to retain its shape, as the casing is not rotated), the shoe of the hand-drill, at the start perfectly flush with the casing inside and out, soon wears to a tapered shape, with the greatest bevel on the outside. This, of course, results in forcing aside material that properly belongs to the core.

The actual value of all drilling results is entirely dependent upon the representative nature of the core obtained. If an excess of material from the productive layer be secured, unless allowance be made for that excess, the results obtained from that hole will be proportionately high. A deficient core from the productive layer, on the other hand, gives results unfair to the ground.

In all that has been written upon this subject, this question has either been ignored, or a method of keeping the core-record has been advocated to which we venture to take exception. This method is, briefly, to compare the total measured volume of core obtained, upon



Pulling Pipe in Korea.

completion of the hole, with the theoretical volume required by the cross-sectional area of the casing and the depth driven. This practice gives a false sense of accuracy; for a deficient core at one stage of the drilling is often balanced by an excessive core at another. If the excess happens to come from the rich layer, the results will be too high, although the total measured core checks the theoretical. An unscrupulous driller, knowing that his core was deficient at one point, could counteract this by deliberately taking an excess at another; yet the records would fail to show this.

In order to overcome these drawbacks, and to keep a record of the cores obtained at each pumping, we measure carefully in the box all the material derived from each successive foot of sinking, and compare it with the theoretical volume based on the actual sinking of the casing. Thus we are able to tell at any time whether excessive or deficient cores are being obtained. The method of keeping the record is shown in the accompanying log.

The keeping of an accurate record of all operations is of the utmost importance in drilling. Forms of records have appeared from time to time in various publications. Most of these, even when intended for use with the hand-drill of the Banka type, have been patterned after the Keystone form. As the two types of drill differ essentially in method of operation, the latter form of keeping the record will not serve for use with the hand-drill. For instance, the amount of core extracted cannot be measured by the difference in core in the casing before and after pumping. During pumping, the pipe may be sinking; the core may be forced out by the pump; slight excess may come in when the pump nears the bottom of the shoe; all of which tend to make this method only serviceable as an approximation.

On the opposite page we give our method for keeping records.

The following is the explanation of the columns:

(A). In this column, the actual depth of the casing is recorded after pumping. If taken before, the sinking of the pipe during pumping causes inaccuracy. From this column, the theoretical core is calculated.

(B and C). These columns serve as an approximation, to show whether the core gained is properly proportionate to the amount of sinking. For the reasons above stated, they cannot be used as an accurate measure of core extracted. Any sudden influx is indicated here. It will be noted in the example given that all cores have been pumped to zero. In some gravels this is a dangerous practice, as excessive cores are likely to result from it. Usually a core of about 1 to 2 inches is left.

(D). This is the theoretical core, calculated by multiplying the depth in feet that the casing had actually sunk by 0·1134, in the case of a 4-inch drill. When there is a core left after pumping (C), this of course must be considered.

(E). This is the actual volume of extracted core obtained by measurement in the box after draining and replacing the slime caught. The depth of the material is measured in 10 or 12 places by a steel rod, the average taken and the volume calculated. As stated later, the measured actual volume is from 10 to 15% greater than the theoretical; however, this is partly compensated by a slight loss from the box in slime. The whole is later measured in the large tub after the work is finished, and compared with the summed result of this column, as a check. Owing to the deposition of the slime, the tub measurement is usually a trifle larger than the sum of the box measurements.

(F). Shows the size and quantity of gold, thus defining the 'pay-streak' or productive layer.

(G). Indicates the formation, and

(H). Contains any additional information, such as the use of the auger instead of the pump, presence of buried timber, etc.

A sample of one of our actual logs is given. In this hole, the final measured volume was 100% of the calculated theoretical volume.

It will be noted that at the pumping depth of 4·7 ft. there is an excess of about 100% of actual core above the theoretical. Had this been in the pay-streak, a deduction would have had to be made from the final weight of the gold in the hole.

The extra work involved in taking the necessary measurements is negligible and does not interfere with the work of the panner.

It is well known that there is a slight expansion of volume of the gravel, after it has been drilled, over its natural volume in place. The amount of expansion of gravel under these conditions (that is, after being broken up, re-deposited under water from the pump, and drained) has never, so far as we are aware, been carefully or accurately determined. In one of the maker's issued pamphlets, a statement is made that "careful work by a drill crew" gave a measured core of 1·37 times the theoretical volume. The reason for this being "careful work" is given

DRILL RECORD.

Property.....
Line No..... Hole No.....
Details .....

Water-Level.....13 ft.	Weight of Gold.....
Depth of Bedrock.....5 yd.	Value of Gold.....
Dredging Depth .....5 yd.	Value per cu. yd.....
Depth of Hole .....15 ft.	Weight in Test .....

TIME RECORD.

Date	Drilling		Pulling		Moving		Lost	
	From	To	From	To	From	To	From	To
Jan. 12...	9.0 a.m.	4.30 p.m.					6.30 a.m.	9.0 a.m.
,, 13...	7.0 ,,	11.0 a.m.	11.30 a.m.	12.30 a.m.	12.30 a.m.	1.0 p.m.	,,	7.0 ,,
Total.....	11 Hr.		1 Hr.		30 Min.		3 Hr.	

Remarks: Time lost due to instructing new crew and repairing battering ram.

Total Volume of Core Measured in Box.....1,604 cu. ft.
,, ,, ,, ,, Tub.....1,736 ,, ,,
Theoretical Core.....1,735 ,, ,,
Ratio of Measured to Theoretical Volume 100%

Remarks: New shoe: 7 teeth broken out of 12. Very stiff ground.

Reverse Side of Sheet.

Depth of Casing in feet	Core in Casing		Core Volume		No. of Colours			Formation	Remarks
	Before Pumping	After Pumping	Theoretical	Measured in box	Size 1	Size 2	Size 3		
A	B	C	D	E	F	F	F	G	H
3.0	3.0	0.0	0.340	0.340			0	Top soil	Boring
4.0	1.2	0.0	0.113	0.114			1	Fine gravel	
4.7	0.9	0.0	0.079	0.155			tr.	,,	
5.0	0.4	0.0	0.034	0.110			tr.	,,	
6.5	1.7	0.0	0.170	0.060			0	,,	
7.5	1.2	0.0	0.113	0.092			0	,,	
8.8	1.0	0.0	0.147	0.091			tr.	,,	
10.0	1.4	0.0	0.136	0.120			1	,,	
11.3	1.6	0.0	0.147	0.122			4	,,	
13·0	0.8	0.0	0.192	0.105			2	Sand & gravel	Drill sticks
14·0	1.4	0.0	0.113	0.145			3	,,	
15·0	1.4	0.0	0.147	0.150		1	1	Bedrock sand	Hard bedrock
			1.731	1.604					

in the statement that "gravel that has been excavated has from 30 to 40% more volume than when in place." This may be true when referring to loose gravel; but for gravel broken up, washed, and laid down again under water, it appeared to us entirely too high. In order to determine the real proportion, the following tests were made:

Volume of Gravel in Place	Volume of Gravel after washing measured	Ratio of Expansion	Kind of Gravel
	cu. ft.	%	
0.48 × 0.78 × 1.37 ft. 0.513 cu. ft.	0.518	101	Very fine Gravel and sand
0.5 × 0.92 × 1.6 ft. 0.736 cu. ft	0.848	115	Medium Gravel
0.925 × 0.474 × 1.43 ft. 0.627 cu. ft.	0.690	110	Medium Gravel

In the light of the above tests, an ideal working of the drill (that is, without excessive or deficient core) should give in ordinary gravel 110 to 115% of the theoretical core. In a recent examination, the ratio of the core obtained to the theoretical volume varied between 80 and 105%. By careful drilling 90 to 100% of the theoretical value can usually be obtained. Using the gold from this amount of material, and employing the theoretical pipe-formula, will give results that have been automatically discounted from 10% to 25%. This is proved by the fact that the above tests show an actual expansion of 10 to 15%, whereas careful drilling gives but 90 to 100% of the theoretical volume. This discount does for the hand-drill what the Radford or Keystone formula does for the power-drill. It will be remembered that the latter formula discounts by nearly 15 per cent.

The pipe-formula usually employed in calculating results with the Banka hand-drill for gold, is this:

$$\text{Value of gravel per cu. yd.} = \frac{\text{Value of gold recovered} \times 240}{\text{Depth of hole in feet.}}$$

In drilling tin alluvium, the results are required in pounds of tin per cubic yard of material, and the tin concentrate is weighed in grammes. In order to save calculation, we are accustomed to using the following formula, with a 4-in. drill:

$$\text{Pounds of concentrate per cu. yd.} = \frac{0{\cdot}525 \times \text{gm. of concentrate obtained}}{\text{Depth of hole in feet.}}$$

The Banka, as well as the Keystone, and, in fact, all drills, must be checked, in any final examination, by shafts, and any formula used must be modified and corrected in the light of the results obtained from the shafts. In this way the personal factors of the driller and crew, the character of the gravel and the gold, and all local conditions that affect drilling, are determined by actual empirical test, and the total cumulative effect can be applied and the drill results adjusted accordingly.

Reliability of Banka Type.—These drills have come into vogue so recently in testing gold alluvium that the results obtained upon ground that has been subsequently dredged are meagre. A case is quoted by the American makers of the drill, in which the ground, after being prospected by their machine, was subsequently dredged with a recovery of from 90 to 100% of the prospecting results. This statement, as it stands, is misleading and is of little use as a guide in discounting drilling to obtain dredging results. It does not indicate the ratio of theoretical to measured core; and it is possible that in this case the driller obtained a proportionately low actual core, thereby unconsciously discounting his results.

When figuring the actual dredgable value of the ground, we would employ on deposits such as those in Oroville at least the same discount of 20 to 25% on results obtained with this drill as in the case of those with the Keystone. The possibility of adopting an arbitrary factor for discounting drilling results in any type of drill has been mentioned already.

Comparison of Hand and Power Drills.—Each type of drill has its own particular scope. The Keystone is to be preferred in places where the ground is heavy, roads are fairly good, labour is expensive though skilled, and repair shops are available. These conditions exist in California, and the power-drill is employed exclusively there. On the other hand, where transport is a serious problem, labour is cheap, and the ground fairly free from nests of large stones, the hand-drill must be employed.

The main advantage of the Keystone over the Banka is that it can drill stiffer ground and deeper holes. It requires for operation a panner, a driller, and a fireman, as well as a man and team to haul water, fuel, casing, etc. Its disadvantages are its higher cost, its weight, its liability to expensive repairs, and its cumbrousness in moving over heavy, wet, or rugged ground. In pulling pipe, the threads are often stripped, resulting in loss of casing; and at times the operation of pulling is a long and tedious one. The former difficulty could readily be obviated by the adoption of flush joints and heavier threads.

The Banka hand-drill is less expensive, costing about £250 complete with spares; it

is light, weighing about a ton, and portable. It requires few, if any, repairs, and with the exception of renewal of shoes, not many extra parts. The shoes, however, are expensive (costing $12·80 each in New York), and we have found a shoe to have been bevelled even on the completion of the first 60-ft. hole. The drill requires a panner, four men on the platform, and a man and horse for motive power. If a horse is not available, men must be employed for the work of turning. Despite the photographs furnished in the before-mentioned pamphlets, showing a man turning the drill with chain tongs, we have found that in the deep holes it requires at least 8 men to turn the drill. This was in the tropics, where our crew consisted of 12 men, affording an opportunity for the men on the platform to change frequently with the men on the sweeps. It would have been impossible to work one crew of 4 men continuously on the platform for 10 hours per day. Where the ground is stiff and heavy and the gravel shallow (under 20 ft.), and labour expensive, the Alaskan hand-drill can be used to better advantage.

Recently, one of us had occasion, in Southern Siberia, to hand-drill a deposit that proved to be unadapted to this method of testing. We mention it as an illustration of hand-drill limitation. The deposit consisted of loose gravel 9 to 15 ft. deep, containing some large stones, and resting on a hard upturned shattered sandstone bedrock. The gold was exceptionally coarse, nuggets as large as peas being common, and it occurred generally deep within the crevices, joints, and bedding-planes of the bedrock quite out of reach of the drill. Some of the gold was found beneath boulders embedded in the ground and lying upon bedrock. As would be expected, the deposit was patchy. Fifteen holes, systematically laid-out, were drilled and they gave discouraging and erratic results. To test as far as possible the reliability of the drill, a series of holes was put-down across a valley, midway between shafts that had been sunk during the winter. These shafts were 50 ft. apart and had given results of 20 cents to $1·20 per cu. yd. Though the holes were sunk into bedrock, the drill failed to find any gold whatever, and consequently this method of testing was discontinued. The deposit is to be tested by pitting during the winter months by alternately freezing and thawing the ground, and owing to the uneven distribution of the gold, the pits are to be placed as close together as circumstances will allow.

Speed of Drilling.—While in actual operation, the Keystone sinks at a faster rate than the hand-drill, yet if the time lost in moving be considered, the latter averages about the same number of feet per day. In ordinary gravel, two 60-ft. holes per week was about our average. The pulling of the casing, with the hand-drill, ordinarily requires only about an hour for a 60-ft. hole.

In Keystone drilling in California, we have been able to drill about 30 ft. per day in ordinarily stiff gravel, but the time lost in pulling and moving reduced the weekly average to that of the hand-drill as given above.

In general, they are all excellent drills in their respective fields; but each requires, for careful work, considerable experience in operation. In order that confidence may be placed in the work, it must be done conscientiously, and the cores obtained should be normal and representative. Also the pipe-formulas used should be applied with discretion.

Number and Distribution of Holes.—This depends chiefly on the character of the deposit and distribution of the gold. Of course, the more holes per acre, the more accurate results, but the greater the examination cost. In the Oroville district, where the gold was more or less uniformly distributed throughout the gravel, as soon as the character of the deposit was known, one hole per acre was considered sufficient. In new and untried districts, or where the ground shows a tendency toward spottiness, the holes should be closer together. Where the gold occurs in channels, holes are placed at regular intervals from 200 to 500 ft. apart, intermediates being put-down where necessary, to define the limits of the channel. The rows are usually started 1000 ft. apart; but this distance is determined by local conditions, and should be left to the discretion of the engineer in charge.

It is often possible to segregate and reject low-grade or barren areas, thereby reducing the yardage, but bringing up the average value for the remaining ground. In this way sufficient yardage may be proved to justify the installation of one or more dredges. Having proved the yardage and determined the character of the gravel, the type and size of the dredge can be decided. From the work of dredges operating under similar conditions, the working cost per yard can be fairly accurately estimated; consequently the expected yearly profits can be determined. Knowing the total life of the property, the profit to be derived, and the cost of equipment and installation, its present worth can be calculated. Comparing this with the cost of the property, its value as an investment may be approximated.

DISCUSSION

Technical Terms.

The Editor:

Sir—In your November issue, Mr. C. Nielsen writes to point out a supposed inconsistency in the remarks in my letter published in your September issue. Mr. Nielsen has evidently misunderstood my meaning, and it seems, therefore, well to explain the point he raises.

Mr. Nielsen, I think, has the idea that I have in mind larger 'patches' of ore than is the case when I speak of "patches that may never be known." The conditions I have in mind are that, within a certain area of a deposit surrounded by development work, the areas, which as a whole will be considered as having to be excavated, may contain certain patches of unprofitable mineral, while the areas that, as a whole, will not be excavated (being too poor) may contain certain patches of ore. This being so, cases may occur where patches of unprofitable mineral in the general area to be worked, may not be touched by the surrounding development, and, on the other hand, cases may occur in the areas not to be excavated where patches of ore will likewise escape the discovery of surrounding development. True, some of such patches may subsequently be found and excavated. Still, patches may remain undiscovered and unexcavated. It is my idea that the poor patches in the one case and the good patches in the other case may be expected to compensate one another, on the general theory of probabilities, supposing the areas of productive and unproductive ground do not differ greatly. On this supposition, and calling all ore surrounded by workings 'developed,' even though actually untouched by the development, the estimate of developed ore would not be made erroneous by the existence of such patches, inasmuch as the developed ore would be as likely to be greater as to be smaller than the estimate. The fact to be borne in mind is that some of the ore developed (or surrounded by development) may never be excavated. I did not, as suggested by Mr. Nielsen, mean that "untouched" and "never known" patches of ore should be included in estimates of developed ore. I meant that patches of poor lode, surrounded by ore and untouched by development, might be included in the estimate of ore, whereas the patches of ore surrounded by poor ground and untouched by development, which would tend to balance such poor ground if discovered, do not in actual work do so because they (or some of them) remain "untouched" and "never known."

Of course, the point of importance is the ability to judge as closely as possible what proportion of the area of ore so indicated by development as to be excavated, may be expected to prove unprofitable, and, therefore, to be left standing. This point can be met by a study of the ore distribution in the particular deposit. I failed perhaps to put the case as clearly as I might have done, and thereby courted misunderstanding on this point. Certainly, in my opinion, with irregular deposits, or, rather, with deposits in which the distribution of ore is irregular, allowance should be made, when making estimates, for the probability of there being barren patches in apparently (judged by development results) unbroken blocks of ore. Further, that the allowance should vary according to the nature (irregularity, etc.) of the ore distribution.

H. R. SLEEMAN.

Perth, W.A., January 4.

Ore.

The Editor:

Sir—Perhaps it is "better late than never" to join in the discussion on the definition of 'ore,' although your recent interesting editorial on this subject was perhaps intended once for all to put an end to this controversy, which has been going on for some time.

Your definition reminds me of the old question: "What is dirt?" the answer to which is often given as "matter in the wrong place." Apparently a rock still remains dirt, apart from the sense in which it is sometimes used by miners, when metal cannot be extracted from it to economic advantage. However, I

think your definition hardly meets the case, and I would submit, with due deference, the two following examples. Firstly, let us take the case of ordinary 'pyrites,' free from copper, or 'pyrite' as some prefer to call it. Nobody will contend that this is not an 'ore,' but no doubt you and nearly everybody else is conversant with the fact that this ore is not mined for its metallic contents, but merely for the sulphur that it contains, being in most cases subsequently used for the production of sulphuric acid and other chemicals. We have here, therefore, an ore which is not mined for its metallic contents. It may perhaps be argued that the iron, after the roasting of the pyrite, is used in the iron industry, but this is only of fairly recent date, and for many years huge heaps of pyritic cinders accumulated that could not be disposed of. Secondly, I would like to know how you can reconcile the fact that the metal sodium, which is a metal, is extracted from common or rock-salt by electrolysis, after conversion of the former into caustic soda. Here we have the reverse side of the medal; we have a metal that is extracted from a raw material which I think hardly anyone would call an 'ore,' although it is obtained in salt mines.

I could enlarge upon these examples, but I just give them as they occur to me, and perhaps these two instances will give some food for meditation.

O. J. STEINHART.

London, February 19.

[These phases of the subject were discussed by us in our reply to Mr. Holloway on page 244 of the October issue and in reply to Mr. Collins on page 367 of the December issue.—EDITOR.]

The Editor:

Sir—I have followed with considerable interest and no little amusement the discussion that has been appearing for some time past in the columns of your excellent periodical on the vexed question as to what constitutes 'ore.'

This most elusive term, this 'De Wet' among definitions, has evaded capture long enough, but let us hope that, like its notorious prototype, it will soon be 'rounded up' and so carefully secured that it will cease to be a source of confusion to the mining community and of danger to the general public.

Judging by the opinions that have appeared in print and by those that I have heard in conversation, it would appear that your definition of ore, namely: "Metal-bearing rock that can be exploited to economic advantage," though possessing the great merit of conciseness, does not receive the approval of a considerable proportion of the mining profession. To my mind, the qualifying words "to economic advantage" narrow the limits of this definition to such an extent as seriously to impair its usefulness, and consequently its chances of general adoption, the reason being that economic advantage is dependent on so many circumstances which in themselves have no direct connection with the metal-bearing rock itself. Let us take, for purpose of comparison, the case of a prospector who discovers and works a seam of coal; the incentive that stimulates his efforts is the hope of getting material gain, but, whether he succeeds in carving a fortune out of the ground or whether he fails to pay his expenses, it is incontrovertible that the name of the mineral exploited remains the same in both cases, namely, coal, and it is equally beyond dispute that the name 'coal' would still apply to this mineral even if the seam were so thin and so cut-up by faults as to render its exploitation to economic advantage an impossibility under the most favourable geographical conditions and financial circumstances.

Such being the case, therefore, it appears to me to be highly illogical that when a metal-bearing rock is being exploited, the purely accidental circumstance of its unprofitability should be the cause of a complete alteration in its name.

The definition of ore should be, in my opinion, a broad and comprehensive one. For greater precision, this generic term (if I may so describe it) can be subdivided into numerous classes by the use of qualifying words; thus we may have the subdivision 'gold ore,' which signifies a class of ore in which the most important metallic content, from the miner's point of view, is gold. In a similar manner the qualifying terms 'high-grade' and 'low-grade' may also be applied to ore, the dividing line between the two classes being a particular grade, which, however, is subject to variation owing to commercial considerations. This classification, therefore, though convenient, should not be considered a hard-and-fast one, for the obvious reason that ore that at one period of a mine's life could not be exploited to economic advantage might very easily be a source of considerable revenue at a later period, as the result of increased output, higher extraction, reduction in freight, or of any other economic factor.

A few days ago, while looking through the

discussion in your paper entitled 'Persistence of Ore in Depth,' which was read recently before the Institution of Mining and Metallurgy, I noticed the following definition of ore which was given by Mr. W. H. Trewartha-James: "Ore is any metalliferous substance occurring abundantly in the bowels of the earth, which attracts the attention of the miner." This definition, though excellent in many respects, is not sufficiently comprehensive, to my mind, as it makes no allowance for alluvial or any other form of surface deposits; by employing it as a basis, however, I have evolved the following definition, which, though not so concise as I could wish, may possibly be found to answer the purpose required. It is as follows: "Ore is mineral matter, other than carbonaceous, which occurs in sufficient quantity to attract the attention of the miner."

This definition will be found to include, in addition to 'hard-rock' metalliferous deposits, all alluvial and surface deposits, also precious stones, sulphur, and non-metalliferous deposits generally; in addition to which, it includes all semi-natural deposits such as stacked tailing of sand or slime, and it might even be taken to cover slime-pulp, as, for example, the tin-bearing slime treated on the Red river in Cornwall.

It eliminates, however, all mineral occurrences of purely academic interest, inasmuch as these have no attraction for the miner; similarly, deposits of clay, slate, and stone (other than precious stone), are also eliminated, because they concern the clay-worker and quarry-man rather than the miner. Again, all varieties of coal, and all the natural hydrocarbons, such as mineral oil, mineral wax, and asphalt, are excluded as they come under the term 'carbonaceous."

Should it be desired, however, to restrict the word 'ore' to metalliferous deposits only, I beg to submit the following definition: "Ore is metal-bearing mineral matter, which occurs in sufficient quantity to attract the attention of the miner."

A. TREVOR ROBERTS.

Mines Department, Northern Nigeria,
January 21.

[This letter harks back to points that have been discussed in an earlier stage of the discussion. The ability to "attract" is hardly definitive. If that is to define ore then any big outcrop of barren quartz becomes 'ore'; so does any iron-stained hillside. Ore is an economic term; if it is to be divorced from economics, it had better remain as it is now: the sport of every careless optimist and the play of every reckless scribbler.—EDITOR.]

The Editor:

Sir—I have both sympathy and respect for your efforts at attempting to reduce mining terminology to a basis approaching, at least, some degree of logic. But not only do I find it impossible to agree with you in your suggestion for a revised definition of the term 'ore,' but I cannot help concluding that your remedy is even worse than the disease.

It seems to me that in order to clarify a term that applies to the economics of commerce you seek to "rob Peter to pay Paul" by imposing an even worse ambiguity upon a substance which, hitherto, had been extremely inoffensive.

It is true that some office-boys connected with the London quarters of some West Coast mining companies during the last few years appear to have assumed a license to introduce some statistics in periodical reports which transgressed both technique and common-sense. Realizing that 3 or 4 dwt. rock is hopelessly below the economic horizon, but in some cases having a hundred tons of such material for every ton of profitable stuff, they dropped into the senseless habit of incorporating the tonnage of the hopelessly improfitable with their other statistics. Such individuals might well reduce their actions to pure logic by continuing their definitions and statistics to the further refinement of giving the actual tonnage measurable in which any gold whatever exists, after which to continue their tabulations to the surrounding country-rock. But because of such transgression against both common-sense and usage I fail to see why the profession, as a technical body, should by reason of the above designated absurdity attempt to remedy further possibilities for evil in a certain direction by perpetrating a useless and laboured ambiguity in another.

I fully appreciate that the term 'ore' applied to a mineralized gangue where the assay-values are hopelessly below any economic possibility leaves something to be hoped for in the way of a definition; and although over twenty-five years close association with most of the phases which the term implies would make lengthy habits hard to eradicate, I would whole-heartedly attempt the mental readjustment, let go the old and embrace the new, providing the new presented satisfying credentials. But it seems to me that in this instance you are advocating a most serious operation when all that the patient requires is

a slight purgative to rectify a minor constitutional disturbance.

My first association with any form of ore was of the tin streams and dumps of old Cornish mining operations; and my experience since that far-off time has been on four continents. In a certain obtuse and indefinite way I have had my own conception as to what constitutes 'ore' in a mining sense and have always associated it with the necessity for qualifications. But instead of such qualifications conducing to ambiguity to me they have appeared as both definite and sensible.

If, from a metallurgical standpoint, the academics of extreme refinement are brought to bear upon either the old or any suggested substitute term for mineralized rock, probably no invention will stand exact dissection and analysis. Doubtless you will realize this even when you proffer the definition that ore is "rock from which the miner may reasonably expect to extract metal to his economic advantage." As a matter of fact, when I read this, your latest suggestion, I 'gurgled' at contemplation of the fresh load of trouble which your broad shoulders would have to bear in the form of criticism.

Is it not a fact that there are certain words and terms that will not permit of synonymous expression? Words and terms that, by reason of usage and general acceptance, fit grooves that will not permit of substitutes? I think so, and further extend the suggestion that the word 'ore' is an illustration.

As this discussion has progressed, I have asked myself the frank question what sort of a definition could I give for the term 'ore'—in a mining sense—if called upon to do so without opportunity for considering subtleties, and the following is my contribution: Ore is a substance in which metallic elements are concentrated in a gangue or matrix, transcending in economic importance and general physical constitution the conditions existing in the surrounding country-rock.

Whether the ore can or cannot be considered an economic factor does not appear to me any point for consideration. We are looking for a term to define a physical condition in this case and any commercial attribute of that physical condition should be made to take care of its own side of the question.

The time has gone by when the term 'ore' only applies to some such exact metallurgical condition as cinnabar, for example, and any holding to such restriction is surely an application of refined pedantics to a practical issue. And whether or not the pedagogue has subscribed to a broadening of the term to some such degree as the definition I have given above, the fact remains that usage has long ago practically settled the question. And to say that usage, in this instance, is empirical, and transgresses a fundamental, is practically asserting that the English language has degenerated from some immaculate conception rather than that it has evolved through travail.

It seems to me that all of this controversy over the definition of the term 'ore' is a sidetracking of attention from a phase of commercial sloppiness to an innocent and eminently respectable technical domain. Example: Mr. Blue Sky writes in his prospectus that the Hot Air mine has several billions of ore 'in sight.' Now whether our friend has several billions of 'ore' on his property, or only a few score never appeals to any sensible person for one moment. The question involuntarily arising in the mind of anyone with even a neophyte's conception of what 'ore' actually is, consists of the query: What are the assay-values of that ore, and what are the commercial possibilities?

I form the impression that the whole tenor of your arguments is to the effect that the term 'ore' ought not to be used or sanctioned unless the material so designated is susceptible to profitable exploitation? Surely you might just as well argue that no bookseller shall use the term 'book' unless the production in question is bound in leather, has gilt top, deckled front edge, and hand-tooled superscription on the back. A book is a book no matter how inferior the workmanship bestowed thereon. This, I assume, you will admit. And similarly I contend that ore is ore, no matter what are its probable commercial aspects.

Of course, one can ask whether barren vein-matter bearing only the minutest traces of metals comes under the designation of 'ore'; but similarly one could also ask whether one sheet of paper bound within two covers and containing only one word is a book or not. A reduction to an absurdity is by no means a criterion of logic.

The fact of the matter is that 'ore' is a physical condition that ranges through imperceptible gradations from the pronounced down to the obscure. Modern metallurgical methods demonstrate that the economic line is almost daily being forced farther and farther down this series of gradations. Where the end will be only an extremely wise man or a fool can afford to conjecture.

Instead of attempting unnecessarily to reform a most useful, direct, and concrete in-

stance of mining nomenclature, it would seem to me that all that is required is to take an 8-lb. hammer and hit a few crooks on the head who make a specialty of living up to their designation in the mining world. Even if we could actually find an expression that would better suit our demands in this matter of 'ore' we would not have helped ourselves with the class of gentry who now prostitute the term. In fact, we would scarcely have settled down with satisfaction at having endowed an expression with a certain defined attitude when the aforesaid crook—or idiot—would immediately hug its utilization to his bosom and go cheerfully on his way of prostitution.

As to your arguments that the Mansfeld material becomes 'ore' when war conditions make copper worth 30 cents per pound in Germany when it is only half that amount in the United States, and drops back into another category for definition with an adjusting of conditions to the normal, etc., these do not appeal to me as being up to your usually high standard of logic. I am no prophet, nor the son of one, but I think I am safe in asserting that you will get far more antagonism than support in that line of reasoning: and an antagonism not generated from hostility *per se*, but from outraged reason.

'Ore' is a physical condition derived from the concentration of elements originally existing in magma, solutions, or gases. It would be stretching argument to the breaking point to assert that this condition can exist in an ordinary massive formation. Therefore the condition surrounding its existence is contradistinctive to the ordinary country-rock. Its economic value depends upon *(a)* the richness of the original source, and *(b)* the sympathy of physical agencies for its concentration. If *a* and *b* are propitious, then we have ore possibly susceptible to commercial exploitation; if the reverse, not so. But, in my humble opinion, the material itself, all the same, is 'ore.'

I hope to live long, but never long enough for my mental susceptibilities to become ossified. Through youthful environment my education was enforced more through means of pick and shovel than by those more enviable means that more favoured mortals had for their lot; and the only way I can 'catch even' is by cultivating a monkey-like acquisitiveness in purloining ideas from those whose natural qualifications and attainments present to me opportunity for assimilation. I hope to continue in this frame of mind to the end. I even think I would feel inclined to manifest interest and inquisitiveness with the gentleman who, under normal conditions, takes his last 'crack' at us—the undertaker. And if there was anything to be learned in that direction, providing it were physically possible, I would start down the last grade ruminating over the value of the last extended suggestion. But, Mr. Editor, although I have tried for the past few months to view your suggestions as to a better definition of 'ore' in a most receptive manner, it 'sticks.' I cannot 'get it down.' Perhaps the conditions relating to my youth, previously referred to, has something to do with it, but 'there you are.'

A short time ago I wanted some petrological help and sent some specimens of rock to two trained petrologists for microscopic examination. Now it so happened that the rock in question was so highly metamorphosed that it was impossible to determine the genetic agency. The farthest either of the petrologists would go was that the rock in question was 'a highly altered feldspathic rock, of pyroxenic constituency, with metamorphism so complete as to obscure its genesis.' Of course I am taking this matter a little further, and in course of time hope to 'move up a peg' in the determination of this rock; for if no other reason existed, and even if there were no technical qualities of interest involved, it is obvious that I could not send out some orders to my mine-foreman to take a little more or a little less of that "Highly altered feldspathic rock which contains pyroxenic elements" when he made his next 'set up.' But I should be no worse off in any such request than were I compelled, by reason of an unsettled terminology, to direct the self-same foreman to see that in his next run he took more care in mining "rock from which the miner may reasonably expect to extract metal to his economic advantage." I think I should utilize something to this effect: "Please see that your ore is maintained at a better grade."

All of which, perhaps, are only more arguments to you that I am, after all, unpardonably behind the times.

JOSEPH RALPH.

Salt Lake City, February 5.

[This further criticism from the other side of the Atlantic is welcome. Truly it is difficult to formulate a definition generally acceptable; but the one merit of the one under discussion is its recognition of the economic relation: in other words, the idea of profitable exploitation. Mr. Ralph's definition begs the whole question; it is the difference between

'ore' and 'country rock' that we are trying to establish. By a change in economic conditions, particularly the price of metals, 'ore' and 'country rock' exchange places. With much that Mr. Ralph says, we agree, but the book simile is laboured. A 'book' depends upon its form, an 'ore' on its commercial value. Any definition can be reduced to an absurdity, but that is not proof of its essential absurdity. The fact that Mr. Ralph would not direct his foreman in the language of a careful technical writer does not prove that careful speech is unnecessary. However, we publish his letter with pleasure, because it is interesting.—EDITOR.]

The Editor:

Sir—The definition of 'ore' in your editorial, January 1915, will, I think, be accepted by a majority of the profession, as covering modern usage as fairly as can reasonably be expected, and I am sure you will be pleased to know that several members of the Institution of Mining and Metallurgy have expressed their approval of that definition.

Not only does it cover mining and metallurgical usage, but it answers fairly well to the general requirements of the legal profession for use in ore-contracts, deeds, conveyances, etc., for the legislature and for merchants.

We cannot, however, expect any definition to cover every possible case, and it leaves such terms as 'sulphur ores,' 'fluxing ores,' and few others outside the pale, as, for instance, pyrite when used only as a source of sulphur, may not be called a sulphur ore. You, yourself, might still desire to further revise your definition; for instance, it might read: "Ore is rock or mineral from which the miner or metallurgist expects to extract metals or minerals to economic advantage."

You will, I am sure, be glad to have evidence that a suitable definition has been obtained through your efforts, and we are all indebted to you for placing the columns of the Magazine at our disposal in this instance. It shows that patience and intelligent consideration can go a long way toward reconciling opinions that at first appeared too widely divergent to make an accepted definition practicable. Please accept my congratulations. For myself, I am glad to express my approval.

W. H. TREWARTHA-JAMES.

London, February 23.

[We thank Mr. Trewartha-James for his goodwill in the matter. He is one of several engineers to take a helpful interest in our effort to arrive at a useful definition. Whether we have succeeded or not, the significance of 'ore' has been clarified, thanks largely to their co-operation.—EDITOR.]

Prospecting for Alluvial Tin in Nigeria.

The Editor:

Sir—Referring to Mr. J. T. Dixon's letter in your February issue, I cannot imagine what remarks in my article led Mr. Dixon to suppose that I was in favour of keeping the hole in advance of the casing in alluvial drilling. I particularly pointed out that the operator should be able to determine at a glance the position of the bottom of the tool with reference to the bottom of the casing, but, unfortunately, by a slip, the word 'rod' was used instead of 'casing' at the end of the following sentence (page 40): "The special lengths of casing and rod should always be used so that the operator can see at a glance the position of the bottom of the tool in relation to the bottom of the rod." The last word should, of course, be 'casing'; as it stands, the sentence is meaningless. My next sentence in the text reads: "The former should, of course, be always slightly above the latter," referring to 'tool' and 'casing.'

I should have thought that to anyone conversant with drilling, the slip would be obvious, and that my meaning would not be inverted. At the same time, I am glad Mr. Dixon has drawn attention to the point.

As regards measuring the sample from a bore-hole as a check, I described this method on page 37 of my article.

G. STEWART PATERSON.

Tynemouth, February 15.

Lead Pencils.—In our February issue we published an editorial note relating to the manufacture of lead pencils, and to the other uses and to the sources of graphite. George Rowney & Co., a London firm established 125 years ago and holding the Royal Warrant, write to us to say that they and other English firms continue to make lead pencils. The flood of German and American pencils has not yet swamped the British firms. Moreover, this firm exports pencils to the United States at the present time. In enumerating the countries that are sources of graphite, we omitted Mexico. Messrs. Rowney inform us that Mexican graphite is largely used in the manufacture of pencils. We are glad to take the opportunity of recording that English firms are making great efforts to meet the demand caused by the cessation of supplies from the enemy countries.

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	Feb. 1 1915	Mar. 1 1915
RAND:			
Bantjes	14	10	10
Brakpan	51	49	49
Central Mining (£12)	160	120	119
Cinderella	6	3	4
City & Suburban (£4)	52	49	44
City Deep	66	59	55
Consolidated Gold Fields	43	27	27
Consolidated Langlaagte	35	34	31
Consolidated Main Reef	18	19	17
Crown Mines (10s.)	120	79	82
Durban Roodepoort	21	20	20
D. Roodepoort Deep	17	16	15
East Rand Proprietary	33	29	29
Ferreira Deep	47	45	44
Geduld	23	21	22
Geldenhuis Deep	26	23	22
Heriot	55	55	60
Jupiter	5	3	4
Kleinfontein	24	19	21
Knight Central	8	5	6
Knight's Deep	35	25	20
Langlaagte Estates	20	18	18
Luipaard's Vlei	10	9	7
Main Reef West	7	6	6
Meyer & Charlton	115	106	101
Modderfontein B	89	91	88
Modderfontein, New (£4)	263	260	254
Nourse	27	25	21
Primrose	21	17	12
Rand Mines (5s.)	120	92	88
Randfontein Central	17	14	12
Robinson (£5)	57	41	31
Robinson Deep	33	24	26
Rose Deep	43	39	35
Simmer & Jack	12	9	8
Simmer Deep	1	1	1
Springs	11	16	16
Van Ryn	67	59	59
Van Ryn Deep	47	47	45
Village Deep	40	37	35
Village Main Reef	40	35	30
Witwatersrand (Knight's)	71	64	57
Witwatersrand Deep	48	39	39
Wolhuter	14	12	13
RHODESIA:			
Cam & Motor	19	16	16
Chartered	17	12	11
Eileen Alannah	11	9	10
Eldorado	18	14	14
Enterprise	9	6	4
Falcon	14	13	11
Giant	14	9	7
Globe & Phœnix (5s.)	32	32	31
Lonely Reef	27	25	26
Shamva	46	35	36
Wanderer (5s.)	3	2	2
Willoughby's (10s.)	7	6	5
OTHERS IN SOUTH AFRICA:			
De Beers (£2 10s.)	330	195	199
Glynn's Lydenburg	11	12	11
Jagersfontein	78	55	52
Premier Diamond (2s. 6d.)	152	75	75
Sheba (5s.)	4	3	3
Transvaal Gold Mining Estates	37	39	37
WEST AFRICA:			
Abbontiakoon (10s.)	8	9	9
Abosso	14	9	7
Ashanti (4s.)	16	15	15
Broomassie (10s.)	2	2	2
Prestea Block A	15	12	12
Taquah	15	14	14
WEST AUSTRALIA:			
Associated Gold Mines	7	5	5
Associated Northern Blocks	7	5	5
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	50	50
Great Boulder Proprietary (2s.)	14	15	17
Great Boulder Perseverance	2	2	2
Great Fingall	9	5	5
Ivanhoe (£5)	50	46	46
Kalgurli	36	34	37
Sons of Gwalia	23	21	21
Yuanmi	3	2	2

	July 1 1914	Feb. 1 1915	Mar. 1 1915
OTHERS IN AUSTRALASIA:			
Blackwater	16	15	15
Consolidated Gold Fields of N.Z.	13	11	11
Mount Boppy	10	11	11
Mount Morgan	52	46	46
Progress	10	7	5
Talisman	33	29	30
Waihi	42	39	41
Waihi Grand Junction	25	26	24
AMERICA:			
Alaska Treadwell (£5)	162	152	140
Buena Tierra	15	15	14
Butters Salvador	20	10	10
Camp Bird	9	8	7
Canadian Mining	—	9	9
Casey Cobalt	13	7	6
El Oro	14	10	9
Esperanza	15	9	10
Granville	10	—	—
Kirkland Lake Proprietary	74	34	34
Mexico Mines of El Oro	97	86	82
Oroville Dredging	10	12	12
St. John del Rey	15	15	15
Santa Gertrudis	11	11	11
Tomboy	22	24	23
Tough-Oakes	28	14	13
RUSSIA:			
Lena Goldfields	43	29	31
Orsk Priority	7	—	—
Siberian Proprietary	3	—	—
INDIA:			
Champion Reef (2s. 6d.)	11	11	11
Mysore (10s.)	93	86	85
Nundydroog (10s.)	27	25	25
Ooregum (10s.)	23	24	25
COPPER:			
Anaconda (£5)	126	111	104
Arizona (5s.)	36	—	—
Cape Copper (£2)	60	50	55
Chillagoe (10s.)	1	½	½
Cordoba (5s.)	6	3	3
Great Cobar (£5)	3	4	3
Great Fitzroy (5s.)	½	¼	¼
Hampden Cloncurry	27	21	24
Kyshtim	55	45	44
Messina (5s.)	15	12	12
Mount Elliott (£5)	55	71	71
Mount Lyell	23	23	23
Rio Tinto (£5)	1355	1150	1165
Sissert	25	21	22
South American Copper (2s.)	22	12	12
Spassky	52	41	40
Tanalyk	78	47	46
Tanganyika	40	28	29
Tharsis (£2)	125	—	—
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	28	18	20
British Broken Hill	36	21	25
Broken Hill Proprietary (8s.)	36	33	37
Broken Hill Block 10 (£10)	32	22	24
Broken Hill Block 14 (25s.)	6	—	—
Broken Hill North	52	39	42
Broken Hill South	175	117	140
Sulphide Corporation (15s.)	26	16	17
Zinc Corporation (10s.)	19	11	14
ASIA:			
Burma Corporation	28	30	31
Russian Mining	31	20	18
Russo-Asiatic	151	80	80
TIN:			
NIGERIA:			
Bisichi	8	7	7
Jos (5s.)	5	5	5
Kaduna (5s.)	15	15	15
Naraguta	17	17	17
N. Nigeria Bauchi (10s.)	3	1	1
Rayfield	5	4	4
Ropp (4s.)	100	19	17*
OTHER COUNTRIES:			
Aramayo Francke	31	25	27
Briseis	5	5	5
Cornwall Tailings	17	10	12
Dolcoath	11	9	8
Geevor (10s.)	5	2	4
Gopeng	27	26	27
Mawchi	20	1	4
Pahang Consolidated (5s.)	7	6	6
Renong Dredging	36	24	22
Tekka	55	57	55
Tronoh	26	26	30

*Denomination of shares recently changed from £1 to 4s.

PRECIS OF TECHNOLOGY

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.]

Gold in Ashanti.—At the February meeting of the Institution of Mining and Metallurgy, J. Morrow Campbell presented a paper describing occurrences of gold in dikes at a spot about 30 miles west of Coomassie, Ashanti, West Africa. In travelling westward from Coomassie, the country is first granite and afterward schist. Both formations are covered with laterite and partly laterized detritus, and the schist where exposed is so much weathered that the original composition cannot be determined. Along the lines of schistosity, lenses of quartz have been formed, some of them being auriferous. The length of these lenses is as a rule not more than a few feet, though in some cases they are several hundred feet long. These lenses have yielded, by denudation, most of the alluvial gold extracted from the stream-beds and flats by the natives. At no place is the schist or the quartz sufficiently rich in gold to be worth working. The dikes studied by Mr. Campbell have usually been described as granite, but many of them are not. In any case the gold is not found in the granite dikes, so consideration of them may be dismissed. Mr. Campbell describes three of the auriferous dikes that are not composed of granite. All three are comparatively ancient, and show evidence of the continuation of the crustal movements to which they owe their existence. These movements have produced fracturing, and have resulted in the formation of quartz veins traversing the igneous rock in all directions and varying in width from over a foot to mere partings. No. 1 dike has an outcrop many yards wide and several hundred yards long, consisting of non-plastic hydrous silicate of alumina, mostly pure white in colour and containing practically no primary quartz. Even at 100 ft. depth the rock is too much weathered for its original composition to be judged, but in all probability it is a syenite. The secondary quartz veins may be divided into two groups: the larger veins formed first, white and glassy, and containing little metallic mineral; and the smaller veins, formed subsequently, often highly auriferous, the gold being associated with pyrite and arsenopyrite. In the oxidized zone, which the natives work for gold, are to be found silicious streaks stained yellow, pink, red, or brown, indicating the former presence of sulphides. These bands are almost invariably auriferous, and guide the native miners. The gold recovered is usually coarse, especially when attached to quartz. Sometimes it shows, under the microscope, a crystalline structure, pseudomorphous after orthoclase or arsenopyrite, but the interfacial angles are not sufficiently well defined to permit of determination by goniometric measurement.

No. 2 dike has resisted weathering better than No. 1, and the rock is easily identified as syenite. It consists of little else than an aggregate of felspar crystals, orthoclase predominating. Practically no primary quartz is present. Throughout the mass are found numerous crystals of arsenopyrite measuring up to ¼ in. diameter. Also, skeletal crystals of the same mineral, the laths of which lie at 60° and 120° from each other, are developed along microscopic passages in the rock, through which mineralizing solutions have passed, depositing them along with quartz and other secondary minerals. Around these passages, for a short distance, the original rock-structure has disappeared. With the larger crystals of arsenopyrite are found wedges of quartz and other secondary minerals, occupying spaces between them and the felspar. Pyrite also occurs in small quantity, often in contact with arsenopyrite, in which case the latter is usually corroded. The conditions indicate that some of the arsenopyrite is of secondary origin and that probably none is magmatic; that silica and arsenopyrite were deposited from the same solution or from solutions traversing the same passages almost simultaneously; and that pyrite was introduced subsequently to arsenopyrite, or that the latter underwent decomposition with the production of pyrite. The gold in this dike is usually associated with arsenopyrite, but it also occurs in the quartz. The gold is sometimes found in an unusual form, being in small spheres from 0·02 to 0·5 millimetres in diameter with striated surface.

In No. 3 dike the original rock is the same as in No. 2 dike. The arsenopyrite crystals in the matrix are smaller and less abundant, and little pyrite is seen. On the other hand, quartz veins and stringers are more numerous. In the body of the larger quartz veins arsenopyrite occurs in irregular masses weighing several pounds. The quartz and arsenopyrite have been fractured many times in various directions, and the resulting cracks, which vary from microscopic size to several millimetres in width, have been filled indiscriminately with gold or quartz, or both. This tertiary quartz is often perfectly transparent. When oxygenated ground-water came in contact with the dike, the arsenopyrite was attacked; dendritic passages were formed throughout the arsenopyrite, and these were filled or partly filled with scorodite, that is hydrous ferric arsenate. The water gained entrance by further cracks, which may or may not coincide with previous lines of fracture. The track of this water is clearly indicated by the deposition of scorodite. Where the scorodite has been formed in contact with arsenopyrite, the latter is dull in appearance, being pitted and corroded. Where gold or quartz is in contact with arsenopyrite it always displays a bright surface, though frequently showing signs of corrosion. Sections show clearly that oxidation to scorodite took place after the deposition of the gold, for the numerous gold and quartz filled cracks are seen to have acted as barriers to the passage of the corroding solution. The quartz veins in the syenite were formed long after the syenite was intruded through the schist. Arsenopyrite was probably introduced in the same solution as deposited the vein-quartz, just as in No. 2 dike the same solution deposited arsenopyrite and silica. The arsenopyrite sides of the larger and first-formed cracks are frequently deeply pitted, many of the resulting holes branching as they extend inward. 'Dendritic' is the best term to apply to them. They are usually filled with gold, but sometimes with quartz. They all end in the arsenopyrite and do not connect with other cracks. Frequently the smaller veinlets run between and apparently connect the dendrites longitudinally, but this arises through the later cracks having developed along lines of weakness created by the cavities. These gold dendrites, when isolated, are seen to be marked in such a way as to suggest crystalline structure, but as the quartz dendrites are similarly marked it is concluded that all are merely casts of holes corroded in the arsenopyrite. The most likely explanation of their origin is that after the cracks were formed some corrosive solution, probably the auro-silicate itself, passed through and pitted the sides deeply. In any case these dendritic cavities were made and filled before much of the other fracturing took place. Some sections show dendrite-filled arseno-

pyrite fractured, and errant gold dendrites broken away from the cracks are to be seen in the midst of quartz veins now widely separating the corresponding portions.

In this region, pyrite is abundant in quartz veins and elsewhere and is unassociated with gold, but wherever arsenopyrite occurs it is so often associated with it that the connection cannot be considered fortuitous. Laboratory tests show that if the arsenopyrite is suspended in a weak solution of auric chloride, numerous small crystals of gold are deposited on it. In the case of No. 3 dike it is fair to conclude that the arsenopyrite caused the precipitation of the gold, and that the solution transporting the gold contained the gold in the form of silicate or as alkaline auro-silicate. Anyway the evidence points to a single solution having deposited gold and silica simultaneously.

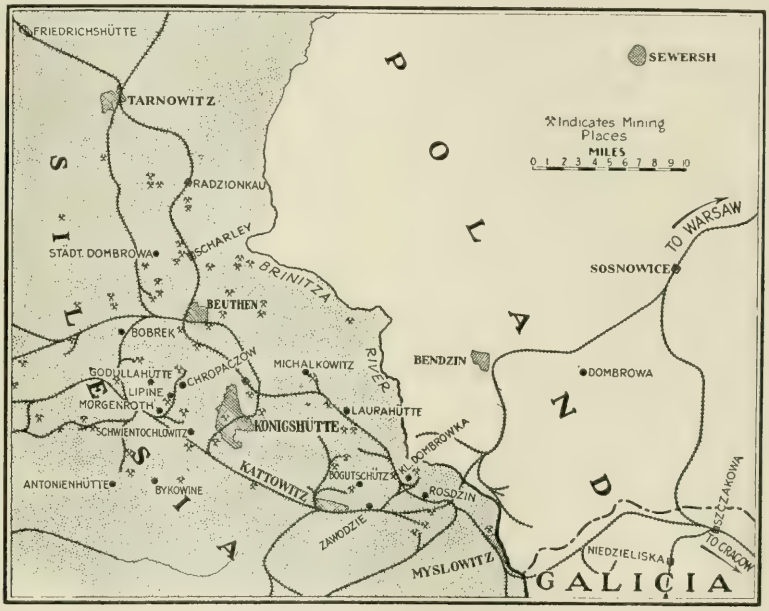
THE BELGIAN ZINC DISTRICT.

Zinc and the War.—At the December meeting of the Mining and Metallurgical Society of America, W. R. Ingalls gave an address on the mining and metallurgical industries in the war zones in Europe. His account of the zinc industry is of special interest. From early times the existence of a great zinc deposit was known at Vieille Montagne, in Belgium. Authentic records show that it was worked in the 12th century, for the production of brass, the ore being smelted with copper ores. Up to 1878 it had produced 1,600,000 tons of concentrate from 200,000,000 tons of crude ore, most of which was won subsequently to 1838, the date when the Belgian zinc industry began to attain importance. For the last few years practically no zinc ore has been mined in Belgium. The Vieille Montagne mine is situated in what was until recently the neutral territory of Moresnet, a state or rather township covering 1½ square miles. This area was in dispute at the time of the settlement of European boundaries after the Napoleonic wars, and it was not until 1905, when some enterprising individual threatened to establish a rival Monte Carlo there that by agreement with Germany the territory was absorbed by Belgium. The classic fable has it that Abbé Dony invented the distillation process for making zinc in the year 1807. He erected a furnace at St. Leonard, a suburb of Liége. He obtained a grant of the Vieille Montagne mine as recompense. Before that time the ore had been used for making brass at Liége, Namur, and Dinant, in Belgium, and at Stolberg and Aachen in Rhenish Prussia. This early history with regard to Dony is not quite credible, seeing that the distilling process originated in India or China, and was introduced in England in 1740, in Siberia and Carinthia in 1798. Whether or not Dony really invented the process for himself, it is certain that he founded the Belgian industry. Ore was subsequently drawn from other mines, at Bleyberg, Welkenradt, Verviers, Corphalie, and Philippeville. Fuel was drawn from the coalfields extending from Mons through Liége into Rhenish Prussia and Westphalia. Excellent fire-clay was obtained at Andennes. Subsequently, when the local supply of ore became scanty, it was easy to import ore through Antwerp and deliver it thence by the excellent system of canals. Thus many zinc smelters have been established along the Meuse valley, at Angleur, Ougrée, Hermalle sous Huy, Sart-de-Seilles, Ampsin, Engis, Sclaigneaux, and elsewhere, while over the French border there are smelters at St. Amand and Auby. In more recent years the development of the coal deposits farther north, in the Campine district near the borders of Belgium and Holland, encouraged the erection of smelters there, so that we find works at Overpelt and Lommel in Belgium and at Budel in Holland. The roasting plant and sulphuric acid plant of the Vieille Montagne company is at Baelen-Wenzel. A zinc smelter is to be found at Boom near Antwerp, and the famous desilverizing works is at Hoboken nearby. Many of these Belgian works are controlled by German firms, notably the Hoboken refinery which is in the hands of the Metallgesellschaft, and the zinc smelters at Overpelt, Lommel, Prayon, and Engis which are controlled by Beer, Sondheimer & Co.

The other zinc-smelting district of Europe is Upper Silesia, which is a great industrial centre of Germany, second only to Westphalia. Here we have zinc and lead mines and smelters, and iron furnaces, while the coal measures provide the necessary fuel for metallurgical and manufacturing industries. These activities extend over the borders into Poland and Austria-Hungary. The important cities in Upper Silesia are Beuthen, Koenigshütte, Kattowitz, and Myslowitz, all lying near the Polish frontier. Lead ores are smelted at Rosdzin and Tarnowitz, and zinc ores at a large

number of works too numerous to mention. In Poland, zinc ores are smelted at Bendzin and Dombrova. The Dombrova basin is one of the most important sources of coal in Russia. In Austria-Hungary, province of Galicia, there are zinc-smelting works at Siersza, Niedzieliska, and Trzebinia, in the neighbourhood of Cracow. The incursion of the German armies into Poland has stopped the supply of zinc and of Dombrova coal to Russia. This shortage of zinc has made it imperative for Russia to turn to the United States for supplies.

Developing Properties in the Far East Rand.—At the February meeting of the Institution of Mining and Metallurgy, a paper by W. G. Holford was read reviewing the mining problems of the far east Rand. One of the interesting points he raises is the shape of the milled 55, milling tons per claim 12,500, number of claims 2000. To bring the mine to a basis of 45,000 tons per month milled would take five years and an expenditure of £1,000,000. The productive life of the mine would be 45 years. The first problem to be tackled is the sinking of the two shafts required by law. In most metal-mining regions, the shafts would be rectangular with 5 or 7 compartments, utilizing the whole of the excavated space, and so reducing the amount of excavation work to a minimum. As the life of a metal mine is usually short, timber supports for the walls would be used. Taking into consideration the conditions in the far east Rand in connection with the long life of the mine, the water and the unsafe condition of the overlying strata, and the necessity for ventilation, it became necessary to study



THE SILESIAN ZINC DISTRICT.

shafts. The banket beds in this part of the Rand have a very flat dip, and in many parts are not far from horizontal. The beds are less uniform than in the central Rand, owing probably to their having been deposited on uneven surfaces. Moreover they were subjected subsequently to lateral pressure, whereby the inequalities became more accentuated, assuming the form of ridges and troughs. The auriferous beds are thickest and richest in the troughs, according to Mr. Holford. Experience has shown that the zones profitable to work on the present basis of working cost constitute 50 to 60% of the total banket. The banket beds are from 2000 to 4000 ft. below the surface, and are covered by rocks of the Karroo, or Permo-Carboniferous age. The overlying strata are often unsound from a miner's point of view and contain much water. Under these economic conditions, the exploitation of these great areas must of necessity be conducted on a large scale. Mr. Holford instances a hypothetical case where the yield and profit could not be much less without the proposition losing its commercial value. The average yield is taken at 25s. per ton and the working cost 18s., the percentage of banket the advantages of the circular shaft. As regards material required for lining the shafts, it was found that suitable clay for the manufacture of bricks could be obtained on the spot. The odd parts of the cross section of the shaft, not used for hoisting, afford ample accommodation for ventilation. In sinking, the circular shaft offers better facilities for breaking and handling the rock; the sump is carried downward in the centre; and the drill-holes, with the exception of those round the periphery, are pitched toward the centre, so that the broken rock is thrown toward the buckets and much shovelling is saved. The sides of the shaft can be trimmed and the brick-lining or iron tubbing fixed in place by working on a Galloway stage. In passing through wet strata, the water can be raised from the sump by baling into a tank on the stage, and from this tank it can be raised to surface by an electrically-driven high-lift pump. The Galloway stage has an additional advantage, seeing that it nearly fills the cross section of the shaft, of protecting the men working below from the danger of falling timber, brick, or other material.

Mr. Holford proceeds to discuss the method of

developing the mine after the shafts have been completed. Stations and large orebins are provided at the bottom of each shaft. The use of the self-dumping skip is desirable. Great economy in labour is effected in loading and discharging by this method. A rapid despatch of ore is ensured, and the operations in the shaft are rendered independent of the mine-tramming. In flat workings, controlled ventilation is of prime importance and should be borne in mind when considering the best position for the two shafts. Mr. Holford considers that the shafts should be sufficiently far apart, about as far apart as their height. They should be connected by a main trunk drift, the work on which will be started at once. The direction of the drift should be diagonal between the strike and dip of the bed, so as to secure the safest roof for a permanent way, and at the same time obtain the necessary gradient for drainage. The same trend of direction will be adopted in laying-out the main thoroughfares above and below the No. 1 and No. 2 shafts respectively, each starting from the most convenient position from the two stations. Two other main roads should be driven, branching from these stations, in opposite directions, and as far as possible at right angles to the first roads. As the main drift between the two shafts advances, intermediate roads are driven parallel to the main cross-roads, and connected at intervals of 500 ft. In this way the area is divided into panels. Along each of the four principal roads independent mechanical haulages are installed. These can be extended to serve branches from the roads. The important point is to push these roads to the boundaries of the property and thus provide cheap and rapid transport of the ore direct from the stopes to the bottom of each shaft. During these development operations, temporary devices for ventilation have to be adopted. Usually a brattice is carried along each heading. A thin brick walling can be used advantageously as a partition, instead of brattice, as it is more durable.

As regards methods of mining, the flatness of the ore deposits encourages the use of the long-wall system with modifications, with liberal use of packs formed of timber and waste rock The most recent experience, however, indicates the advisability of varying the method by confining it to individual panels, which should be worked alternately as nearly as the incidence of the profitable zones admit, until the boundaries have been reached. Conditions will then be established favourable to the reduction of costs, by securing safety in working, maintaining a large number of stoping faces, and establishing an average grade throughout the mine. By the adoption of this system of alternate panel mining, many dangers, such as the rising of the foot-wall, can be eliminated. It will also prevent heavy falls of roof, which would otherwise occur during stoping when long stretches of ground are left unsupported. Moreover the tramming will be direct from the working face to the main mechanical transport lines throughout the four sections of the mine.

Tube-Mill Pebbles.—In the *Mining Press* for January 23, Jay A. Carpenter, metallurgist at the Goldfield Consolidated company's cyanide plant, in Nevada, discusses the supply of pebbles for tube-mills, and the possible substitutes, especially in connection with present practice at the all-sliming plants in Nevada. The subject is of special importance to cyanide men, seeing that the chief supply of pebbles comes from Denmark, a source upon which dependence cannot be placed during the war. The utility of the Danish pebbles for grinding purposes was originally discovered by the German cement-makers. When their tube-mills were applied to the fine-grinding of gold ores, the use of the Danish flints was passed along to the gold metallurgists. The Danish pebbles have proved acceptable to the tube-mill manager, as they are extremely hard and tough, nearly spherical, and cheap. Their price depends solely on the cost of gathering them from the seashore and of sizing them and preparing them for shipment. The price of these flints at the Denmark ports is about 45s. per ton. The Danish flints are remarkably homogeneous and free from cleavage-planes or lines of weakness. On being fractured, the faces are sharp and irregular, and vary in colour from brownish-black to jet-black. Occasionally the faces show odd patches of a brown to grey colour, which though softer than the rest of the pebble form apparently an integral part of it. The pebbles as collected vary in diameter from 1 to 7 in. and are graded into eight sizes, varying in diameter from 1 or 1½ in. to from 4¾ to 7 in. The chief sizes in demand are No. 3, measuring 2⅜ to 3¼ in., No. 4 3⅛ to 3¾ in., and No 5 3½ to 4 in. Each of these sizes are graded according to the shape of the pebbles, the spherical being naturally the most desirable. This classification by shape is not fully appreciated by the millman, and purchases are consequently as a rule based on the size rather than the shape of the pebbles. Though the price of these pebbles at Danish ports is about 45s., and at New York 60s., by the time they arrive at the Nevada mines their cost is from £7 to £12 per ton.

A substitute for the Danish pebble comes from France. This has the appearance of the Danish pebble, and is free from fracture-planes. On breaking, its internal colour is found to be light-brown to grey, quite different from that of the Danish pebble. It wears much faster, and though cheaper at the port of shipment, the price at the Nevada mines is not any less than that of the Danish pebbles. Pebbles from Newfoundland have been used, and they are hard enough, though as they have parallel bedding lines they fracture more readily, so that their use is uneconomical. In many places, as in South Africa and Mexico, the harder parts of the ore and country rock are used, and though they wear more rapidly than the special pebbles, their small cost and their gold content compensate in some degree. Steel balls are used in mills where weight and fall are required to crush coarse ore, but they are not suitable where larger grinding surfaces and fine grinding action are required. Recently, artificially rounded pebbles have been employed at the Nevada mines. In order to warrant the cost of erecting and working a tumbling plant to produce such pebbles, it is clear that there must be a local supply of suitable flint, chalcedony, or onyx, and a sufficiently large demand. The manager of the Manhattan mill found a deposit of banded and patchwork onyx that had no tendency to break along the banded lines. He used large quantities of this rock in his tube-mills, and found that after the rough edges had become rounded, the pebbles gave as good results as regards wear as Danish pebbles. Experiments at other mills in the district proved that the preliminary rounding in a tumbling machine is necessary, and such a machine was erected. The pebbles produced are rounded, but are not spherical.

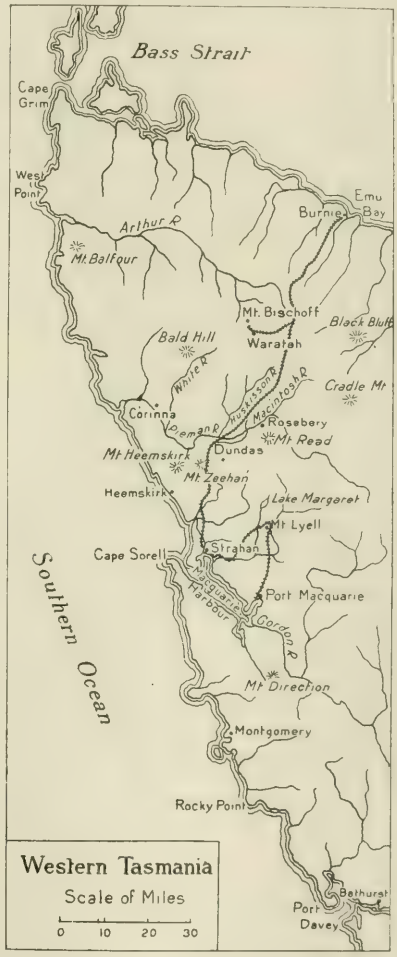
These pebbles, which are known as Manhattan pebbles, are now being tested at Tonopah and Goldfield. The results at the West End mill have been favourable. Two 5 by 18-ft. tube-mills are driven from a common pinion-shaft at the same speed, each taking

the classified sands from 10 stamps with screens having 0·12-in. openings. No. 1 mill has smooth liners and No. 2 has Komata liners, the latter lining being credited with being more economical on pebbles. During August, 12,500 lb. of Danish pebbles was added to No. 1 mill. Beginning with September 1, Manhattan pebbles only were added daily to the mill, totalling 11,640 lb. for the month. As the pebble load of the mill when carried at centre is about 8·1 tons, and the daily charge is about 400 lb., the average life of a pebble is 40 days. Calculating from this, the load should have been about one-half Manhattan pebbles, on October 1. During October there was added 12,190 lb. of Manhattan pebbles, and when the mill was opened the load was at the centre line and all the pebbles except the smallest were Manhattan pebbles. During November there was added 13,490 lb., leaving the mill with a slightly higher load. Comparing the above months, it will be seen that the Manhattan pebble is practically equal, pound for pound, with the Danish pebble, as far as wear is concerned. In November, No. 2 mill took 12,800 lb of Danish pebbles. This gives a comparison of the Manhatton and Danish pebbles as follows: wear ratio, 1·05 : 1; cost per lb. ratio, 0·95 : 1·73 cents; cost per ton ground ratio $1 : $1·75, or a saving of 40% on pebble cost by Manhattan pebbles. To off-set this gain is an occasional delay or stop due to irregularly shaped pebbles sticking in the tube-mill scoop.

While the Manhattan pebble appears to be as efficient a grinder as the Danish pebble in the smooth-liner mill where a large share of the grinding is done by slippage, and the pebbles tend to wear flat, it is a question whether they would be as efficient in the Komata-lined mill, where the pebbles are cascaded, for the more nearly spherical the pebble the more efficient the grinding. They are being tried with this type of liner at other mills in the district. These pebbles are delivered at Tonopah with a wagon haul of 40 miles at $19 per short ton. It is evident that at this price the Manhattan pebble has a marked advantage in price at Tonopah over the Danish, but with freight shipments from Tonopah toward coast points this advantage rapidly diminishes to a vanishing point, leaving this particular substitute for the Danish pebble to the limited field of local use.

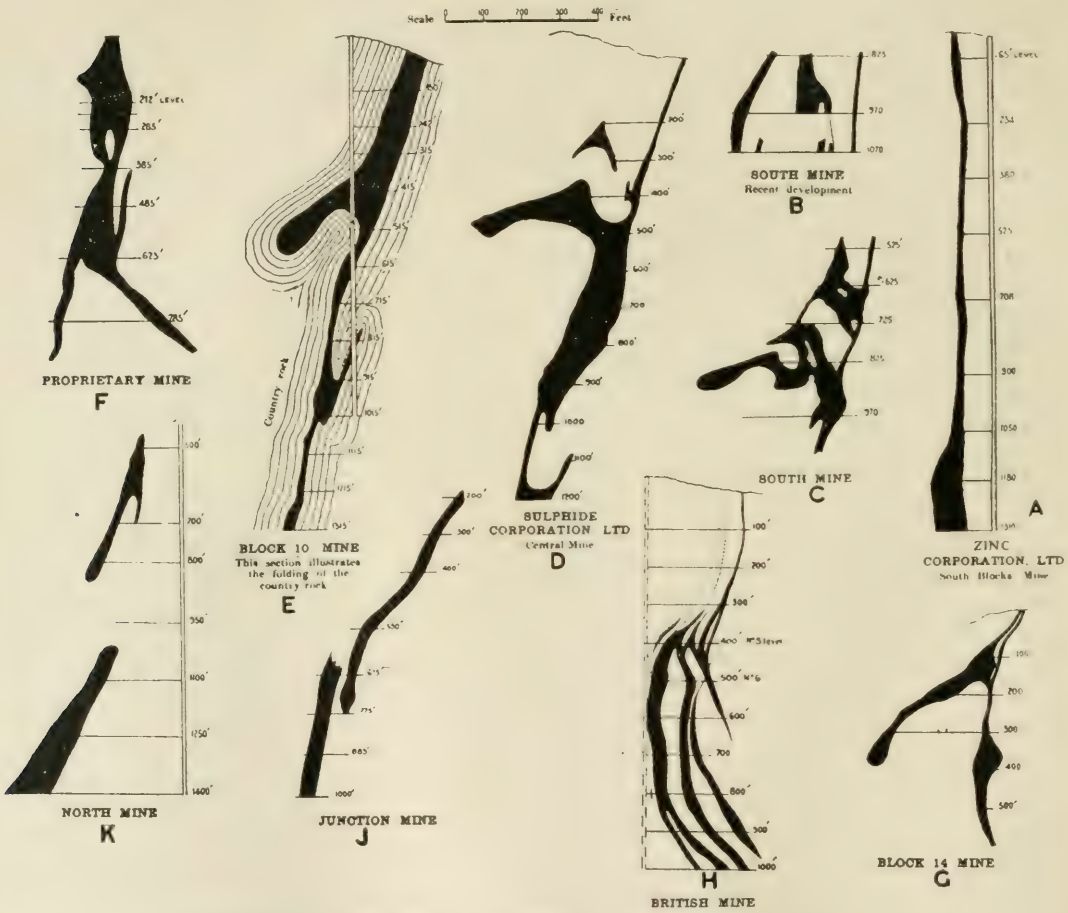
In the February *Bulletin* of the Canadian Mining Institute, Arthur A. Cole states that 1200 tons of pebbles has been shipped from Newfoundland to Porcupine and Cobalt. These pebbles are of greywacke composed of 65% quartz, 5% felspar, 10% chlorite, sericite 5%, set in a fine groundmass of chlorite, sericite, and quartz.

Osmiridium in Tasmania.—In our issue of October 1912 we gave a few particulars of the osmiridium deposits in the northwest of Tasmania. Since then the original matrix of the metal has been found, and the region has been examined by E. J. Dunn. A report by Mr. Dunn is published in the *Australian Mining Standard* for December 24, and we extract the following particulars from it. The workings are in two chief districts known as the Bald Hills and the Wilson River respectively and they are situated between Waratah and Corinna. It is in the first-named district that the original matrix has been found. Here the alluvial workings are along the course of Savage river and its tributaries, notably Nineteen-Mile creek. In Nuggety gully, at the head of the latter creek, nuggets of unusual size have been found, many of them weighing over 1 oz., and all of them much water-worn. In Nineteen-Mile creek, the osmiridium is associated with water-worn gold in flattened scales. Some of the osmiridium scales have coats of gold. On the hill-sides above the heads of the creeks and gullies the osmiridium is also found, in rounded form, a fact tending to indicate that the osmiridium was originally derived from an ancient alluvial deposit hundreds of feet vertically above the present surface of the ground. At higher altitudes the metallic particles are more angular, and prospectors following them upward eventually discovered a zone in the serpentine (the country-rock of the district) containing grains of osmiridium. This zone exhibited signs of



crushing, but there is no evidence of a lode, or of veins of lode-minerals such as quartz or calcite. The particles of the metal are invariably minute, and seldom detected by the naked eye. By milling and concentrating, the particles can be collected in substantial quantity. In one case a lode, consisting of chalcedony veins and limonite, with pyrite below, is said to contain osmiridium. The creeks below contain no metal, so it is certain that the lode did not provide any of the metal found in the alluvium. In the Wilson River district, the country rock is also serpentine, but the osmiridium in the gravel has not been traced to a matrix.

Broken Hill Model.—In the *Australian Mining Standard* for January 7, F. Danvers Power describes, with illustrations, a model of the Broken Hill lodes so far worked. This model has been made by O. Trickett for the Panama-Pacific Exposition, and is an elaboration of an earlier one described by Mr. Trickett in a paper read before the Australasian Institute of Mining Engineers in June 1912. The model is 13 ft. long and represents 3 miles of lode. By its means it is easy to see that there has been a main fault corresponding to the drawn-out limb connecting a synclinal fold on the east and an anticlinal fold on the west which have the main lode as far as the South mine. The main lode itself has a wavy underlie to the west. On the eastern side of the main lode the folds are synclinal, except near Wigg's shaft on the Proprietary, though as the ground between the main lode and the fold has often been mined the structure is not evident. At one place on Block 12 of the Proprietary a double syncline is to be seen. The lode is shallowest at Blocks 13 and 14, which appear to be on the apex. The general strike of the lode is N N E, with a slight curve toward the east at its northern end. The northernmost part, in the North mine, appears in the model to be discon-



CHARACTERISTIC TRANSVERSE SECTIONS OF THE BROKEN HILL LODE.

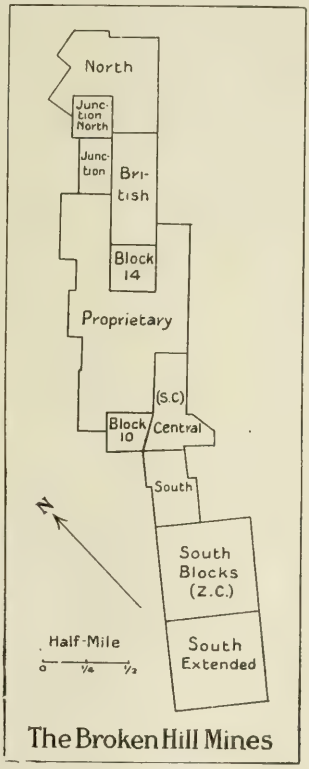
appearance of saddles. These folds are not noticeable everywhere. The northerly workings of the North mine show a saddle-like fold, the western leg of which is longer as far as the workings have gone. Near the boundary of the Junction North and Junction, a branch vein has been discovered, which on further working may prove to be a portion of a fold. The country is disturbed near the boundary of the Junction and British mines, but on Block 14 a saddle-fold again occurs, which is the best developed of all. On Blocks 12 and 13 of the Proprietary, the folds are more complicated. The anticlinal folds are shown by the model to have been developed on the western side of the nected from the lode in Junction North, but the two parts are in reality connected by mineralized rock. We cannot reproduce the photographs of the model here, but we give some of the cross-sections accompanying Mr. Danvers Power's paper. Fig. A shows a section of the main lode, the thick portion at the bottom being a ridge of ore on the western side pitching from north to south. The isolated saddle seen in Fig. D is connected with the main lode on the east, to both the north and south of this section. The portions left white between the dark lines on Fig. H consist chiefly of rhodonite and quartzite; they are really parts of the lode but are not worth working. Fig. E

shows the main lode or fracture following the course of the limb connecting an anticlinal and a synclinal fold; this section may be taken as the best to explain the true nature of the lode.

CURRENT LITERATURE

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.]

Winding Ropes.—At the February meeting of the North of England Institute of Mining and Mechanical Engineers, H. W. G. Halbaum read a paper on the lateral friction of winding-ropes.



Steel Supports.—The *Iron & Coal Trades Review* for January 29 describes the development of the horse-shoe steel arches used for supports at the Tredegar Company's coal mines in South Wales.

Prospecting in Malaya.—At the February meeting of the Institution of Mining and Metallurgy, W. B. Middleton presented a paper describing the methods of prospecting tin alluvium in the Malay Peninsula.

Power Absorbed in Stamp-Mills.—At the January meeting of the Institution of Mining and Metallurgy, James Cook read a paper detailing experiments to ascertain the amount of power actually absorbed in the crushing of ore in stamp-mills by measuring the increase in the temperature of the pulp over that of the ore and water fed to the stamps.

Bullfinch Treatment Plant.—In the December and January issues of the *Monthly Journal* of the Chamber of Mines of Western Australia, A. L. Hay and R. B. Williamson describe the metallurgical plant at the Bullfinch mine. The ore is treated in pans, tube-mills, agitators, and Ridgway filters.

Continuous Filter.—*Metallurgical and Chemical Engineering* for February contains an article describing a continuous vacuum filter, invented by W. W. Robacher, and erected at the concentration plant of the Pennsylvania Steel Company. The filtering medium employed is 'filtros,' a reference to which was made in our December issue.

Holt-Dern Process.—In the *Engineering and Mining Journal* for February 6 and 13, G. A. Keep describes the Holt-Dern furnace and leaching process used at Park City, Utah. A note of this process was given in our issue of December.

Sesekinaka, Ontario.—In the *Canadian Mining Journal* for February 1, Charles Spearman gives an account of the Sesekinaka gold deposits, situated 10 miles north of Kirkland Lake. He also describes the petrography of the rocks and ores.

Coal and Iron in South Russia.—The *Iron and Coal Trades Review* for February 19 contains a historical account, written by J. W. Revillon, of the iron, coal, and manganese industries of South Russia.

Alaska Coal.—In the *Mining and Engineering World* for January 30, W. R. Crane describes the lignite deposits in the region round Cook Inlet and Kachemak Bay, Alaska.

Molybdenite in Canada.—In the *Engineering and Mining Journal* for February 6, W. H. Smith describes the molybdenite deposits in Canada.

NEW BOOKS

Surveying Manual. By Howard Chapin Ives. Leather, small octavo, 310 pages, illustrated. New York: John Wiley & Sons; London: Chapman & Hall. Price 9s. 6d. For sale at the Technical Bookshop of *The Mining Magazine*.

As the sub-title states, this manual is designed for the use of first-year students in surveying. It is intended especially to meet the needs of mechanical, electrical, and chemical engineers, and of students in agriculture and architecture, as well as those in secondary schools. The book contains fourteen short chapters dealing in outline with the following divisions of the subject: General instructions, the chain and tape, the level, the compass, the transit, topographical surveying, the plane-table and the sextant, the aneroid barometer and the planimeter, railway curves, the United States system of laying-out public lands, computations, plotting, latitude, longitude and azimuth, large surveys. At the end there is a set of tables giving, among other things, stadia reductions, logarithms of numbers, logarithmic and natural sines, cosines, tangents, and cotangents, and, finally, an index.

On account of the limitations imposed by the particularized aim of the manual, it does not in any way supersede the existing standard text-books in this branch of study; but for the class of readers for whom it is intended it should, when purged of an occasional looseness of phrase and supplemented with oral instruction, prove decidedly useful. Both print and illustrations are excellent, the matter is well arranged, and the work is pleasant to handle and to read.

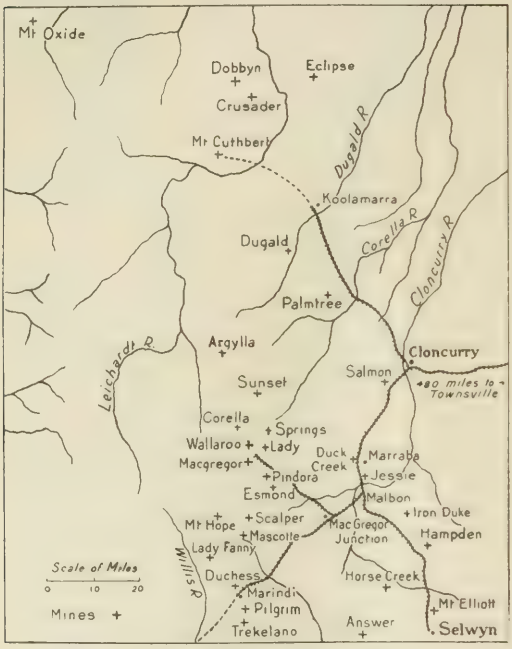
A. R.

Zinc-Smelting in the Middle West. By E. H. Leslie, Paper covers, 40 pages, illustrated. San Francisco: *Mining and Scientific Press*; London: *The Mining Magazine*. Price 2s. 6d. net.

This pamphlet contains a reprint of a series of six articles, which give full technical details of the modern zinc-smelting plants in Illinois and Oklahoma. We have referred to these articles in previous issues in our Précis of Technology and Current Literature.

COMPANY REPORTS

Hampden Cloncurry Copper Mines.—This company was formed in Melbourne in 1906 by the Baillieu group to acquire the Hampden and Duchess properties in the Cloncurry district of North Queensland. More recently the Trekelano, Pindora, Salmon, Macgregor, Answer, Mascotte, and Scalper properties have been purchased. The report for the half-year ended August 31 shows that mining and smelting were continued until the outbreak of war, when the contract for the sale of blister copper to German buyers automatically terminated, and operations were suspended on August 6. Subsequently arrangements were made with the Commonwealth Bank of Australia whereby the bank agreed to lend £30 per ton on 1800 tons of copper. This made it possible to resume smelting on September 9.



THE CLONCURRY COPPER DISTRICT, NORTH QUEENSLAND.

Up to the time of issuing the report on November 16, 1600 tons of copper had been sold. Concurrently with the arrangement with the bank, the employees of the company agreed to accept half salaries, the balance to be paid later within the limit of profitable operation. During the period covered by the report, 11,445 tons of ore averaging 7·5% copper was raised from the Hampden, 14,065 tons averaging 13·2% from the Duchess, and 492 tons averaging 10% from the Trekelano. The smelter treated 36,482 tons of ore for a yield of 3140 tons of blister copper containing 3107 tons of copper, 1045 oz. gold, and 26,670 oz. silver. The ore reserves are estimated by Erle Huntley, the manager, at 249,000 tons averaging 9·5% copper; these reserves are distributed among the following mines: Hampden, Duchess, Macgregor, Wallaroo, Pindora, Trekelano, Answer, and Mascotte. Development on the 420 and 500-ft. levels in the Hampden has been disappointing. It is intended to sink deeper, when provision has been made for the necessary pumps, in order to examine the lode below the zone of secondary enrichment. Work on the 700-ft. level of the Duchess shows a continuation of high-grade ore. At the other properties, the results of development have been of varying nature, and the ore does not appear to go far downward. The net profit for the half-year was £49,444, which was carried forward.

Mount Cuthbert.—This company was formed in Melbourne in 1909 to acquire a group of copper claims situated 60 miles northwest of Cloncurry, North Queensland. W. H. Corbould is the consulting engineer, and R. W. Powell is manager. The report for the half-year ended August 31 last shows that development was suspended at the Mount Cuthbert leases awaiting a new winding engine before starting to sink below the 350-ft. level. The reserves consist of 150,000 tons of 8% ore, and 70,000 tons of concentrating ore averaging 4% copper. Development has been continued at the Kalkadoon, Warwick Castle, and Mighty Atom claims, with results of doubtful though possibly hopeful promise. A survey has been made for a smelter site near the terminus of the railway from Cloncurry, now been built, and tenders are being invited for its construction. The issued capital of the company is £151,366 and there are £70,000 debentures.

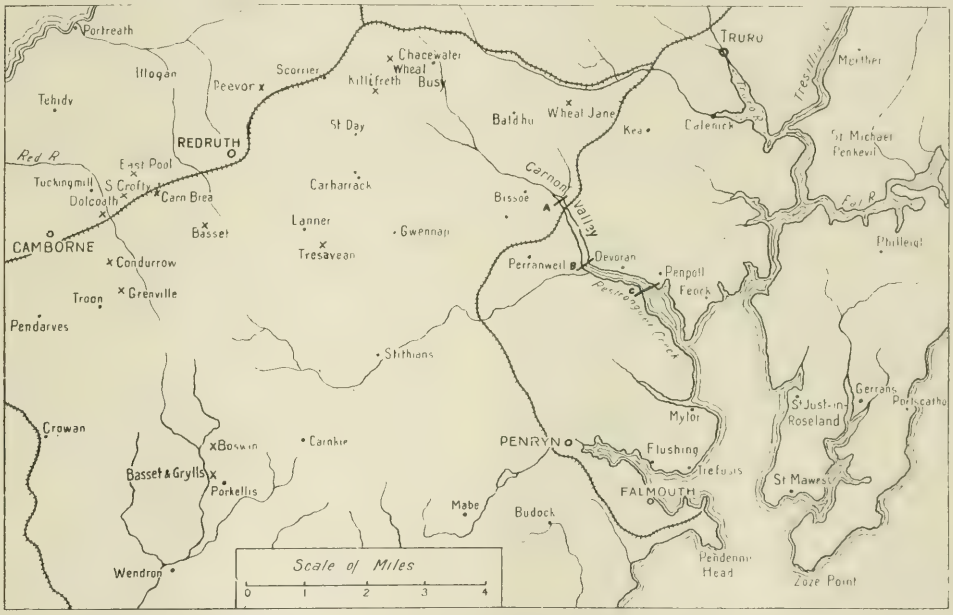
Dolcoath Mine.—The report of the premier tin mine of Cornwall for the half-year ended December 31 shows that it became necessary owing to the low price of tin to draw on the richer reserve in the New Sump section and to mill a smaller amount of ore. The amount of ore raised was 48,058 tons, the yield 710 tons of concentrate, and the total income £59,672, as compared with 57,254 tons, 728 tons, and £67,544 respectively during the previous half-year. The yield per ton was 33·1 lb. as compared with 28·5 lb., and the average price received for the concentrate was £83. 18s. The profit after paying royalty was £3382, as compared with £510. Out of the profit, £2484 was written off for depreciation of plant and buildings. R. Arthur Thomas states that Malcolm Maclaren's geological report on the mine is unfavourable to further exploration at depth in the central and eastern sections, but he does not agree with Dr. Maclaren. Though developments have been unsatisfactory in these sections for some time past, he is of opinion that the sinking of a winze should be continued for another 50 fathoms below the 550-fm. level, and explorations made at greater depth. This winze has already been sunk 84 ft. Development is to be actively pushed in the Wheal Harriet section, to the west. The shaft is now down 452 fm., and is to be sunk to 490 fm. At that level a cross-cut is to be driven to connect with the Williams vertical shaft so as to establish efficient ventilation, and then exploration in the ground farther west will be started.

Carn Brea & Tincroft.—The tin mines belonging to this company, near Camborne, Cornwall, have been worked since 1832. In early days the profits were large, but since the present limited liability company was formed, in 1900, the profits and losses have alternated. For three years, until last summer, E. S. King was manager, and he introduced some improvements, but nothing could be done in the way of finding rich ore, and the Carn Brea section was closed. The report for the half-year ended December 31 shows that 29,372 tons of ore was raised from North Tincroft, for a yield of 304 tons of black tin, being a yield of 23·2 lb. per ton. The income from the sale of black tin was £25,750, and the sales of arsenic, wolfram, and copper brought the total income to £30,964. The average price received for black tin was £80. 6s. The net loss was £283. During the corresponding half of 1913 the loss was £12,899, in spite of the fact that the average price received for

black tin was £19 higher, so that the policy of closing Carn Brea has been justified.

East Pool & Agar.—These mines at Camborne have been worked since 1834, but it was only in 1913 that the company was changed into one of limited liability. The reconstitution of the company was effected when Bewick, Moreing & Co. became managers, they at the same time procuring the subscription of £35,000 new capital. For some years the yield per ton had been low and funds had not been available for the necessary forward development. The report for the year 1914 shows that 81,593 tons of ore was raised and milled, for a yield of 644 tons of black tin, 107 tons of wolfram concentrate, 455 tons of arsenic, and 19 tons of copper concentrate. The total price obtained was £70,008, being 17s. 2d. per ton. The cost including every item was £70,512 or 17s. 3d. per ton, so that the year ended with a small adverse balance. The development with £100,085, the yield per ton being worth 22s. 9d. as compared with 28s. 10d. It has been possible to reduce working costs, which were 20s. 7d. per ton as compared with 22s. 2d. The net profit for the year was £2653, and adding this to the balance brought forward from the previous year, made a disposable balance of £4608. Out of this, £4375 has been distributed as dividend, being at the rate of 8¾%. Mr. Paull gives details of the large amount of development done. Unfortunately no ore of high grade has been found, so that there is no prospect at present of the yield increasing. The directors record that they find no difficulty in selling the wolfram concentrate in this country.

Grenville United.—This company was formed in 1906 under limited liability law to acquire the Grenville tin mines, situated to the south of Camborne, that had previously been worked on the cost-book



THE MINING DISTRICT BETWEEN CAMBORNE, TRURO, AND FALMOUTH.

done during the year has well maintained the reserve of ore. As has already been recorded in our columns, a new lode of considerable promise has been found in a cross-cut north of East Pool shaft on the 240-fathom level. It is notable that the tonnage milled was 13,377 greater than in 1913, the yield of black tin 116 tons greater, and the cost per ton 3s. 3d. less. The milling plant consists of 9 Holman stamps. In these the Loring round mortar-box has been substituted for the older type of square box, with a great improvement in the rate of discharge.

South Crofty.—This company was formed in 1906 by the Allen-Meyerstein group to acquire the tin mine of this name in Cornwall, close to Dolcoath. Josiah Paull is manager. The report for the year 1914 shows that 69,842 tons of ore was mined and milled, for a yield of 644 tons of black tin, 113 tons of wolfram concentrate, and 706 tons of arsenic. These results were much the same as those for the previous year, but owing to the fall in the price of tin, the income from the sale of products was only £79,654 as compared system. Excellent results have been obtained by the manager, Henry Battens, in spite of unusual difficulties with water. Unfortunately a year and a half ago the yield per ton began to fall and no profit was made for the first half of 1914. During the second half of the year, the war and the fall in the price of tin naturally injured the company, and the accounts show a loss of £3511. The amount of ore raised and treated during the half-year was 24,515 tons, and the yield was 315 tons of black tin, or 28·8 lb. per ton. These figures compare with 21,483 tons, 291 tons, and 31 lb. for the previous half-year. Mr. Battens reports that the heavy rains made development and sinking operations difficult, but ore has been disclosed at several points, and the average yield per ton should be higher during the current half-year. On the outbreak of war and the temporary disappearance of the tin market, the black tin was stored, and even after the ticketings were resumed, the directors decided to hold the stock for a rise in price. Consequently the accounts show that of the 315 tons produced, 201 tons was actually sold

during the half-year, realizing £78. 16s. per ton, and that the remaining 114 tons was subsequently sold at £88 per ton.

Arizona Copper.—This company has its headquarters in Edinburgh and operates copper mines near Clifton, Arizona. Résumés of its history have been given in previous issues of the Magazine. The report for the year ended September 30 shows that 1,079,950 tons of ore was raised. Of this, 932,954 tons was sulphide ore sent to the concentrators, and 87,875 tons was oxide also sent to the concentrators, the remainder being sent direct to the smelters or converters. The smelters treated 182,873 tons, and the yield, including copper extracted from the oxidized tailing by leaching, was 19,378 short tons. The troubles in connection with the new reverberatory furnaces have been finally removed, and the extensions of the concentrating plant have been completed. On the outbreak of war and the consequent decrease in the market for American copper, the output was reduced to 1200 short tons per month, but since January 1 the production has been gradually increased. The accounts show an income from the sale of copper of £1,079,580, and a working profit of £288,255, out of which £60,000 has been placed to the debenture-redemption fund, £43,449 was paid as debenture interest, and £24,531 as preference dividend. The ordinary shares receive £132,990, being at the rate of 35 per cent.

Mount Morgan Gold Mining.—The report of this company operating the great gold-copper mine near Rockhampton, Queensland, for the half-year ended November 29 last shows that 134,204 tons of ore was mined and sent to the smelter and 37,151 tons mined and sent to the concentrator. The smelters treated 131,988 tons of ore averaging 2⅜% copper and 7¾ dwt. gold per ton, together with 34,912 tons of basic fluxing ore from Many Peaks mine averaging 1·4% copper and 0·14 dwt. gold. In addition 13,039 tons of purchased ore and other material was smelted averaging 4·4% copper and 10½ dwt. gold. The concentrator is not yet in full working order, and it does not appear from the report that any of the concentrate is as yet being sent to the smelter. An account of this plant was given in our issue of January last. During the period under review, 31,274 tons of silicious ore was treated averaging 2·36% copper and 5·36 dwt. gold. From this was produced 5993 tons of table concentrate averaging 3·29% copper and 11·44 dwt. gold, thus accounting for 26·7% of the copper and 40·9% of the gold, while the flotation plant extracted 3026 tons averaging 13·9% copper and 18·8 dwt. gold, accounting for 57% of the copper and 34% of the gold in the ore. The total percentages of recovery by the two processes were 83·7 and 74·9 respectively. The new smelting furnaces were put into commission in July, and the cost of smelting has been reduced thereby. The output contained 4593 tons of fine copper and 59,309 oz. gold. The report does not state how much of this copper remained unsold at the time of making up the accounts. The net profit for the half-year was £63,835, which was carried forward.

Falcon Mines.—This company was formed in 1910 by the Gold Fields Rhodesian Development Co. to work a gold-copper deposit 60 miles west of Gwelo, Rhodesia. The report for the year ended June 30 last shows that little development was done during the year, and that work was centred on the erection of concentration and smelting plant. The reserve was calculated on June 30 at 178,621 tons of oxidized ore averaging 6·4 dwt. gold and 0·71% copper, and 629,032 tons of sulphide ore averaging 5·5 dwt. gold and 3·15% copper. The orebody has been developed to the 6th level, and recently a 7th has been opened. It will be remembered that a year and a half ago some controversy was caused by the estimates of average assay-value made by two examining engineers, A. H. Ackermann and J. C. Pickering, not confirming those made by the company's engineer, H. A. Piper. The metallurgical plant was completed and trial runs started in June. The ore is sent to stamps and afterward to tube-mills. The pulp is passed over vanners and blankets and thence to a Minerals Separation plant. The concentrate is sintered and smelted in a blast-furnace, and the matte is treated on the spot. From the commencement of milling operations to December 31, 53,429 tons of ore has yielded blister copper containing 904 long tons of copper and 12,989 oz. gold. Of the blister copper 755 tons had been sold at the date of the issue of the report, February 10. The percentage of recovery has been gradually improved to 81·6% of the gold and 91·1% of the copper. The capital expenditure has been greater than was estimated. The share capital is £400,000 of which £200,000 was subscribed in cash, and £300,000 debentures have been issued. Arrangements have been made for further necessary funds. By the end of November the working cost had been reduced to 39s. 8d. per ton of ore treated, and when the plant is working at full capacity, 15,000 tons per month, it is hoped that the figure will be reduced to 35s., as originally estimated

Jibutil (Anantapur) Gold Mines.—This company belongs to the Anantapur group, in Madras Presidency, India, that is under the management of John Taylor & Sons. It was formed in 1911, and additional capital was subscribed in 1912 and 1913. The report now issued covers the year ended September 30 last, and shows that the treatment plant was completed in September 1913, but did not arrive at its full capacity until May 1914, owing to troubles at the Diesel power-station. From the commencement of milling to the end of September 1914, the plant treated 15,480 tons of ore for a yield of gold worth £16,495. This yield per ton was less than the average, and during the last few months the yield has increased to 6½ dwt. It has become clear that profits can only be made by adopting a larger scale of operations and further capital is to be subscribed. W. Stonor describes the development work. The lode has been cut on the 1000-ft. level and has been proved for a distance of 48 ft. to be 34 in. wide and to assay 7·1 dwt. per ton. In a winze sunk below the 800-ft. level ore has made its appearance, which is a hopeful sign, seeing that the workings previously passed through 200 ft. vertical of barren ground. At No. 2 Prospect shaft, 3000 tons of ore averaging 12 dwt. gold has been developed on the east lode.

Wolfram Mining & Smelting.—This company was formed in 1909 to acquire from Dutch owners a number of wolfram mines at Silvares, Portugal. The report for the year ended September 30 last shows that 20,675 tons of ore was raised, chiefly from the Panasqueira mine, and the yield on concentration was 235 tons of wolfram, 4 tons of black tin, and 140 tons of crude arsenic. The accounts show an income of £27,851 and a net profit of £6152. The directors consider it unwise to pay a dividend. In previous years the dividends have averaged 7½% on a capital of £80,000. Owing to the greater hardness of the rock it has been necessary to adopt stoping and hammer drills. On the outbreak of war the sale-contracts were automatically suspended, but it has since been found possible to sell the products in this country.

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Scientia non habet inimicum nisi ignorantem.

EDGAR RICKARD, Managing Director.

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STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
July, 1914	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,584,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3 202,514

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1914	154,202	9,471	11,979	175,652
February 28	157,673	9,508	12,266	179,447
March 31	162,815	9,619	13,390	185,824
April 30	165,005	9,625	14,150	188,780
May 31	165,433	9,619	14,284	189,336
June 30	166,248	9,442	13,256	188,946
July 31	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
January 1914	1,902,733	27 4	18 2	9 3	876,577
February	1,861,442	26 10	17 11	8 10	823,654
March	2,094,098	26 4	17 3	9 1	945,000
April	2,075,561	26 6	17 3	9 3	955 600
May	2,196,287	26 3	17 0	9 3	1,011,968
June	2,178,161	25 5	17 1	9 5	1,025,629
July	2,281,717	25 10	16 9	9 1	1,032,562
August	2,261,800	25 5	16 8	8 9	988,567
September	2,188,939	25 11	16 9	9 1	989,859
October	2,301,795	25 8	16 8	8 9	1,004,264
November	2,192,365	26 3	17 0	9 0	982,346
December	2,167,056	25 11	17 3	8 6	917,662
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

Gold Output of India.

Year 1912	Year 1913	Year 1914	Mar. 1915	Year 1915
£2,265,094	£2,299,315	£2,340,259	£194,350	£591,575

Production of Gold in West Africa.

Year 1912	Year 1913	Year 1914	Feb. 1915	Year 1915
£1,497,179	£1,634,700	£1,727,044	£144,034	£287,683

Production of Gold in Rhodesia.

Year 1912	Year 1913	Year 1914	Feb. 1915	Year 1915
£2,707,368	£2,903,267	£3,530,207	£286,789	£579,922

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
July, 1914	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435.164
September	1,535	103,577	105,112	446,485
October	2,028	99.366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900
March	1829	91,872	93,764	398,282

Other Australasian Gold Production.

	1913	1914	Feb. 1915	1915
	£	£	£	£
Victoria	1,847,400	1,740,300	122,300	192,200
Queensland	1,118,610	1,011,310	85,850	129,620

American Copper Producers' Association's Figures.

In Tons of 2240 lb.

	Production.	Deliveries: Domestic	Deliveries: Foreign	Deliveries: Total	Stocks at end of month
Total 1913	724,307	342,566	387,974	730,540	—
January 1914	58,826	21,409	39,266	60,675	38,933
February	54,715	21,244	37,455	58,699	34,949
March	65,023	31,184	39,983	71,167	28,805
April	67,634	28,315	36,761	65,076	31,363
May	63,530	24,818	32,460	57,278	37,615
June	63,101	20,637	32,745	53,382	47,334

No figures published since, and Association dissolved at end of 1914.

The United States Customs report exports as follows: July 34,145 tons, August 19,676 tons, September 23,866 tons, October 28,995 tons, November 1–28, 20,170 tons, December 7 to January 9, 24,366 tons. January 9 to February 6, 24,998 tons. February 6 to March 13, 18,941 tons. No record is published of shipments between November 28 and December 7.

Nigerian Tin Production.

In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Year 1914 tons	Jan. 1915 tons
2,532	5,032	4,832	417

Production of Tin in Federated Malay States.

Estimated at 70% of concentrate shipped to smelters.

1911 tons	1912 tons	1913 tons	1914 tons	Feb. 1915 tons	1915 tons
43,967	48,250	50,128	49,042	3,780	8175

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January 4, 1915	3282½	£28,353	£86 4 11
January 18	2144¼	£18,785	£87 13 8
February 1	2153¾	£19,892	£96 13 8
February 15	2272½	£21,801	£95 16 7
March 1	2181¼	£21,208	£97 3 5
March 15	2053¾	£20,625	£100 7 3
March 29	2244¾	£21,360	£95 0 10

Imports of Tin Concentrate at Liverpool.

Reported by H. A. Watson & Co.

	March, 1915 tons	Total, 1915 tons
Bolivia	1,557	10,546
Nigeria	612	1,680
South Africa	90	464

REVIEW·OF·MINING

INTRODUCTORY.—The cheerful tone of the mining market, reported last month, has continued, and in many departments on the Stock Exchange there is evidence of substantial purchases in the expectation of further rises. The mines in the far east Rand occupy a large share of attention. The most recent reports from the East Rand Proprietary are more encouraging, ore of more than average grade having been struck on the 27th level in the Angelo Deep section below the Driefontein. Broken Hill shares are strong owing to the settlement of terms for co-operative lead-smelting by the Proprietary, the North, and the South mines; moreover the orders for steel rails afford gratifying support to the Proprietary's iron business. With the production of copper advancing toward normal and with the price strengthening, the shares of copper-mining companies are in demand. Russian shares are receiving renewed attention, those of the Russo-Asiatic and Russian Mining Corporation being once more bought for a rise. The Mexican situation is as bad as ever.

TRANSVAAL.—The output of gold during March was 753,935 oz., of which 727,167 oz. came from the Rand and 26,768 oz. from outside districts. The number of native workers at the end of March was 185,239, as compared with 180,422 at the end of February, and 162,815 at the end of March last year.

As foreshadowed in our February issue, the gold mines are to be asked to pay part of the cost of the rebellion and war. The budget of the Union of South Africa reveals an anticipated deficit of £2,700,000, of which £500,000 is to be met by extra taxation on the mines. This taxation is to take the form of a special war levy, and the amount will be deducted proportionately from the dividends as declared.

The East Rand Proprietary announces excellent results of development on the 27th level in the Angelo Deep section. Three cross-cuts from the western drift on this level have disclosed ore of higher grade than usual. In one of these the Main Reef is 37 in. wide and averages 19 dwt. per ton, and the Leader is 23 in. wide and averages 18·6 dwt., the two being separated by 40 in. of sandstone. These discoveries are welcome, seeing that much of the recent development has been discouraging. The part of the Angelo Deep where these results were obtained is in the western end, on the dip of the Driefontein. Development has here been greatly hindered by water from the so-called Wit Deep water-dike, but it is believed that the 27th level is below the water zone. If so, prospects for future work are brighter.

The French Rand Gold Mining Company is to go into liquidation, as no further funds are available for keeping the mine in working order. The overdraft at the bank has gradually mounted to £30,000 since the mine was closed-down in 1909, and the time has come when the loan must be repaid. The mine was originally worked by French capitalists, but in recent years the control passed to the Rand Mines group. The venture was never profitable, owing to the broken and irregular nature of the deposit, and only two

small dividends were paid. The property is in the far west Rand, near the Lancaster West, the suspension of which was recorded by us two months ago. At one time Mr. W. W. Mein was general manager, with the late T. Lane Carter as mine manager.

The figures for the ore treated and gold recovered during the first three months of work at the Modder Deep are as follows: January 25,750 tons for £34,345, February 28,600 tons for £42,272, March 31,700 tons for £49,153. The yield per ton has advanced from 26s. 8d. in January to 29s. 7d. in February and 31s. 2d. in March. The average grade of the ore fed is about 37s. 6d., and the balance represents the gold locked-up in the circuit. With the increase in the tonnage treated, the working cost per ton fell from 20s. 6d. in January to 18s. 5d. in February and 16s. 10d. in March. The nominal capacity of the plant is 30,000 tons per month.

RHODESIA. — The output of gold during February was worth £286,789, as compared with £293,133 in January, and £259,888 in February last year. Operations at Bell Reef became normal toward the end of the month, after the suspension of mining and milling for some weeks owing to floods.

The mines of the Planet-Arcturus Company, one of the Gold Fields Rhodesian Development group, have been temporarily closed, as the available funds have been practically exhausted and further loans cannot be raised. The ore reserve at the Arcturus, Slate, and Planet mines consists of 335,413 tons averaging 12'3 dwt. of gold per ton. During the past year work has been confined chiefly to the sinking of a new main shaft, which has reached a depth of 259 ft. The amount of money so far spent in development is £200,000, of which £150,000 was provided by the sale of shares, and £50,000 advanced on loan by the parent company. The provision of a metallurgical plant had not been considered. The Planet, the smallest of the three mines, has been let on tribute.

WEST AFRICA.—The yield of gold during February was worth £144,034 as compared with £143,649 in January. The Abbontiakoon shows a decrease in ore treated of 3000 tons owing to an overwinding accident, but the output of gold was increased by £7900 obtained by a periodical clean-up of the tube-mills.

Mr. J. M. Iles sends a report on the progress of the test of the Delimi property belonging to the Rayfield (Nigeria) Tin Company. The two most recent bore-holes have proved the tin-gravel to average 60 ft. deep across a section 80 ft. wide, and to assay 2 lb. of cassiterite per yard. The total length now proved is 1500 ft. measuring from 80 to 150 ft. wide and from 28 to 60 ft. deep. The assays of the various holes vary from 1½ to 7 lb. of cassiterite per yard. The winning of the tin is to commence in June.

At the meeting of shareholders in the Champion (Nigeria) Tin Fields, the chairman, Mr. S. R. Bastard, recounted at some length his attempts at negotiation with the Administrator of Nigeria with the object of removing the many obstacles to successful work, such as the onerous mining regulations, and the high cost of railway transport. He briefly mentioned the alluvial gold deposits on the Barco river, in connection with which the company had applied for prospecting licences. The gold regulations have not yet been published, and some doubt exists as to their nature.

The Ropp Tin Company is issuing debentures for £50,000, but as the meeting of shareholders authorizing the issue was held privately, we are not able to give the reason why this issue has been made. It was only in July last that 75,000 new shares, having a par value of 4s., were issued at £1 each.

INDIA.—In spite of the suspension of production at the North Anantapur during the rearrangement of the metallurgical plant, the figures for the Indian output of gold during March showed no appreciable diminution.

During 1914, the Balaghat, the most northerly of the Kolar group, has not done more than pay expenses, a condition that has ruled for the last five years. In the deepest level of the mine at 3300 ft., and in the winze below, the lode appears to be more promising, for it averages from 32 to 40 dwt. over 12 in. Exploration is being vigorously pushed.

The output of gold at the Ooregum mine during 1914 was worth £367,081, the largest recorded since the commencement of operations over 27 years ago, but the sum distributed as dividend, £138,270, was not as high as that for 1893, when £151,125 was paid. The fall in the average grade of the ore treated is shown by the fact that the yield in 1893 was £280,040 from 42,360 tons of ore, while that for 1914, £367,081, was obtained from 154,898 tons of ore. Whether these figures indicate a general impoverishment in depth, or the necessity for conducting operations on a larger scale as the depth increases so as to decrease the cost of mining, is only known to the managers. The development at depth, however, is at the present time highly gratifying, particularly as the mine is the deepest of all those in the Kolar district.

CANADA.—The abandonment of the option on the Teck-Hughes property at Kirkland Lake by the Nipissing company came as a considerable surprise. The reason is stated to be the sudden impoverishment on the 300-ft. level of one of the most important ore-shoots. The Ontario Bureau of Mines expresses the view that the Cobalt output has reached its maximum, and that a gradual diminution is to be expected in future. At Porcupine, the short supply of hydro-electric power is still causing the amount of work done at the mines to be below the normal.

The developments at depth at the Le Roi No. 2 Company's property at Rossland, British Columbia, have given gratifying results, and a resumption of dividends is foreshadowed. To save the heavy expense of shaft-sinking, the orebody was tested at depth by means of a cross-cut from the adjoining Le Roi mine, which nowadays belongs to the Consolidated Mining and Smelting Company of Canada. The Le Roi No. 2's silver-lead mine at Slocan, the Van-Roi, has not proved a success, the lodes being too irregular and narrow, and the mine is at present closed.

AUSTRALASIA.—The scheme for the acquisition of an interest in the Port Pirie smelting works belonging to the Broken Hill Proprietary by the Broken Hill South and the North Broken Hill companies has been finally settled by the boards of the three companies. A new company with a capital of £650,000 is to be formed to acquire the smelter and to provide working capital. Hopes are expressed that the business will be expanded at a later date so that all the lead concentrate produced at Broken Hill, not already provided for, will be smelted there.

The iron industry of the Broken Hill Proprietary is progressing. The first blast-furnace was started on March 8. Orders continue to arrive from the Federal and State Governments for steel rails.

Reports are to hand that the Mount Lyell company is taking an interest in mines in the Mount Read district. Also that the company is being invited to supply electric current from their new hydro-electric installation at Lake Margaret to the Zeehan district. The Sulphide Corporation is inviting offers of complex lead-zinc ores from Tasmania for shipment to the works at Cockle Creek, New South Wales.

We recorded in a recent issue that the Mount Bischoff company had been obliged to curtail production on account of the fall in the price of tin after the outbreak of the war. Full details of the position are made available by the issue of the company's report for the half-year ended December 31. It appears that work was entirely suspended until Sep-

tember 15, when an arrangement was completed whereby a party of miners, numbering about two-fifths of the normal staff, agreed to work on a co-operative basis. Under this system, 48,354 tons of ore was milled, for a yield of 194 tons of tin concentrate, comparing with 112,239 tons and 525 tons during the previous half-year. For the first time in forty years this celebrated mine has failed to yield a profit.

The Toora Proprietary Tin Fields is to be wound-up and the assets sold. The company was formed in London in 1912 to acquire tin alluvials in Gippsland, Victoria. A year ago reconstruction became necessary in order to provide additional working capital, but so few shareholders responded by paying their assessment that the scheme has had to be abandoned.

RUSSIA.—Last month we recorded that boring at the Amerikansky mine, belonging to the Kyshtim Corporation, had proved a notable lateral extension of the orebody. Later news is to the effect that another bore-hole has proved a further extension. At the Tissoff mine, belonging to the same company, a new bore-hole, penetrating deeper than any other bore-holes, has indicated an extension of the orebody by 150 ft. in depth.

UNITED STATES.—The directors of the Alaska Juneau are offering for sale 400,000 shares at $10 each. It is stated that this issue has been underwritten by Mr. Bernard M. Baruch. This decision of the directors to seek outside financial aid has come as a surprise. The development of the Alaska Juneau property is in the hands of Mr. F. W. Bradley.

The adjoining Perseverance-Gastineau property, owned by the Alaska Gold Mines, and having Mr. D. C. Jackling as engineer, was floated by Hayden, Stone & Co. and the Utah Copper Co., and the speculative value of the shares has been fully appreciated by the public. The first section of the mill was started in January, and is giving excellent results. A second section will be ready in May and a third in July. Later the fourth section will be added, and the total capacity will then be 10,000 tons per day.

The United States Smelting, Refining & Mining Company recently decided to discontinue development at the Ebner property, near the Juneau and Perseverance mines, and has asked the Alaska-Ebner Company to refund the $500,000 spent on the development work. The Alaska-Ebner company cannot find this amount, and is negotiating for the sale of the property to the Smelting Company.

The dissolution of the Amalgamated Copper Company is impending, the chief reason being that the new income-tax laws are unfavourable to 'holding' companies. Anaconda has issued two-years notes for $16,000,000 for the purpose of acquiring the shares of the United Metals Selling Company from Amalgamated Copper. The latter owns $79,609,150 of Anaconda shares, 150,000 Inspiration shares, and 30,000 Greene-Cananea shares.

At the Plymouth Consolidated, Amador county, California, the cross-cut on the 2150-ft. level has intersected the lode, and north and south drifts have been commenced. The work so far done has shown the lode to average 50s. gold per ton over 80 in. On the 1500-ft. level, the south drift is being continued with the object of finding the continuation of the South shoot, which was first discovered on the 950-ft. level and subsequently exposed on the 1140-ft. level. In stoping operations at this mine, the width of the ore proves to be greater than estimated, but the content in the extended portions is lower.

MEXICO.—The little news that comes from Mexico is not reassuring. In the Pachuca district, Santa Gertrudis is working on a 40% basis; there has been a shortage of cyanide. El Oro is isolated, and the bulk of the inhabitants have deserted the town. No news has come through for weeks, and it can be assumed that none of the mines are in opera-

tion. The latest reliable news states that the pumps in the Dos Estrellas were still working.

VARIOUS.—The Tiger tunnel of the Bawdwin mine in Burma is passing through a series of bands of loose running ground. When the central shaft reaches the level of the tunnel, a new heading will be started. The original programme allows ample margin of time for unforeseen interruptions in completing this important work.

The gold mines in Egypt under John Taylor & Sons' control present two points of interest. At the Barramia mine a pocket characteristic of the deposit has been found yielding gold worth £7500 from three-quarters of a ton of ore. At the Nabardi mine, 300 miles southward, belonging to the Sudan Gold Field, one of the lodes has exhibited a sharp fold at the 300-ft. level and has been traced upward for 100 ft., where it once more turns downward. The continuation of the lode after this second bend is now being investigated. This mine has been yielding much richer ore recently, and the company has been able to declare its first dividend, being at the rate of 10 per cent. on a capital of £63,875.

The Rio Tinto Company was hampered by the strike in the early weeks of 1914, and from August onward the output was practically halved, owing to the deliveries of copper and pyrite to Germany being suspended. The sales of copper as metal and as a constituent of pyrite were 21,515 tons as compared with 36,320 tons the year before, and the dividend was 35% as compared with 75%. The directors' report is even more scanty than usual, for no details are given of the production and sales of metal, pyrite, and washed pyrite. Though the output has been so greatly reduced, development work on the new deep shaft at San Dionisio and at the Naya adit is being continued steadily. A heavy expenditure is incurred by these works. The shaft is being sunk for main drainage and hoisting purposes, and the Naya adit is to provide a new outlet at the 16th level for ore from the huge orebody at San Dionisio and also from the South lode. This adit, which is a work of considerable magnitude, is being driven from several faces and will eventually connect the workings with the main line to the port at Huelva at a point considerably lower than the entrance of the present adit at the 11th level of the South lode. The English staff at Rio Tinto has responded handsomely to the call for recruits to the new army.

Cable advices are expected at any time of the starting of the 80-ton mill at the Porco tin mines in Bolivia. Harold Allman Lewis, the new manager, has greatly altered the prospects at the mine by reporting that, in place of a small mine with high-grade ore estimated previously at 50,000 tons averaging 5% tin, he now finds by cross-cutting that he has exposed 250,000 tons of 2½% ore. No difficulty is anticipated in disposing of the concentrate, except a delay in the realization, due to transportation troubles. The Porco mines were introduced in this country in 1912 by the controllers of the Aramayo Francke properties, and Mr. Malcolm Roberts is consulting engineer.

OIL.—The fire at the celebrated Potrero No. 4 well, in the Tuxpam district of Mexico, belonging to the Mexican Eagle Oil Company, has been finally quenched. During the whole time that the fire has raged, oil has flowed through the capping-gear into the storage tanks, and for some time the oil escaping from defective joints has been pumped to storage. Latterly the fire has been confined entirely to gas.

Interest in the Maikop oilfield, in Southern Russia, has been revived by the report of a gusher on the Maikop Combine's property. At a depth of 1318 ft. a light oil was struck, and the upward flow was so great as to damage the drilling apparatus and derrick, and to make a jet 50 ft. high. Owing to the large amount of accompanying gas, all fires had to be extinguished.

EDITORIAL

OLD Camborne students will hear with regret of the death of J. J. Beringer. For twenty-eight years he had been identified with the leading Cornish mining school, and in many ways 'J.J.' and 'the school' were interchangeable terms. His devotion to duty and his unconventional manner will not soon be forgotten. And to the metallurgist, 'Beringer on Assaying' is a classic.

AMONG the passengers on the ill-fated *Falaba* were Mr. Allan A. Davidson, manager of the New Lafon mine, Northern Nigeria, and Mr. A. Goldwater, who was going to the mines of the Ex-Lands Nigeria Company. Two members of the staff of the Ashanti Goldfields were on the boat, Mr. H. I. Johnson, assistant underground manager, and Mr. F. P. Barker, cyanide assistant. Fortunately all of them were among the rescued. Among the unfortunate victims of this sea tragedy was Leon Chester Thrasher, a young American engineer, who was on his way to join the staff at the Broomassie mine.

LAST month we advised our readers not to miss Mr. J. Morrow Campbell's remarks on 'pyrite versus pyrites' made in introducing his paper at the meeting of the Institution of Mining and Metallurgy. We expected that a report of this portion of his address would be published in the March *Bulletin*. The remarks, however, were excised, so we invited Mr. Campbell to contribute them to our 'Discussion' column. As regards the nomenclature adopted at the British Museum, the labour that would be entailed in the alteration of the records and labels would be enormous, and quite beyond the capacity of a staff whose time is already more than filled. Under these circumstances we cannot expect the British Museum to act as a pioneer of logical reorganization of nomenclature.

WE ARE not impressed by the optimism of the chairman of the Champion (Nigeria) Tin Fields with regard to the prospects of the gold deposits in the Barco river district. That gold is found in the gravel of the river is admitted, but the quartz veins in the neighbourhood have not so far been proved to be auriferous. The Chairman refers to twenty quartz 'reefs' along the river, but whether they contained gold or not he confessed he did not know. He was quite satisfied, however, that there was gold in the river, and that it was shed by the 'reefs.' Amateur opinion of this character is not likely to interest shareholders or elicit the sympathies of the Government authorities.

THANKS are due to our many subscribers now on military service for their continued support in spite of their limited opportunity for reading our pages or even thinking of mining matters. Some have written to say that more than ever do they appreciate our endeavours to give reliable and comprehensive information, within a small compass, relating to the progress of mining all over the world. Others who cannot receive their copies at the time of publication are having them stored pending their return, for they know that the eventual study of the accumulated Magazines

will not give them any of that wearying drudgery usually associated with the reading of back files of papers and transactions on the return home after long absence.

THE PROHIBITION of the sale of vodka in the Russian Empire has increased the efficiency of the worker. English and American engineers in charge of mines report that the efficiency of their men has increased by from 30 to 50%, and that the men are saving money rapidly. The Irtysh Corporation is proposing to establish a savings bank on the lines of that at Kyshtim in order to provide means for organizing this new thrift. The British Government would be glad to see the same increase of activity on the part of the men who are engaged in the production of war material, and we may all be asked to make the great sacrifice in order that the end of the war shall be hastened.

IN ANOTHER column we print a communication from Mr. A. R. Goldring, London representative of the Transvaal Chamber of Mines, commenting on our method of quoting the Chamber's monthly statistics of production, working cost, and working profit on the Rand. We take this opportunity of repeating a question put by us to the Chamber in our issue of June 1912 in connection with the figures for the yield, cost, and profit per ton milled. Presumably the sum of the figures for the cost and profit should be equal to the yield, but in many cases they fail to check. For instance, the yield per ton during 1914 is reported to average 26s. 6d., the working cost 17s. 1d., and the working profit 9s. There is a discrepancy somewhere, and an explanation of the method of calculation is desirable.

WE understand that the terms on which 60,000 tons of zinc concentrate has been sold by the Broken Hill Proprietary and the Sulphide Corporation to American smelters are not particularly favourable to the sellers. While the buyers assume the risk of advances in freight rates and of fluctuation in the price of the metal, on the other hand the sellers do not receive any advantage from the higher price of the metal now ruling, and in fact the terms of the contract preclude any additional profits being obtained with zinc over £30 per ton. The contract is practically a sale of concentrate for a fixed sum per ton at the storage bins at Broken Hill. It is a question whether it would not be better policy for these rich companies to save their concentrate for more profitable transactions at some future time, though of course, from the broader point of view, every ton of metallic zinc available now is an asset for the Allies. The tonnage involved in the contracts is equal to about a year's output at the present rate of production, or about 40% of the normal. Before the war, the yearly output of zinc concentrate throughout the Broken Hill district was approximately 500,000 tons, so that the amount involved in the present contracts is not relatively great.

THE contribution by Mr. W. R. Feldtmann to the study of the metallurgy of gold, forming the subject of a paper presented to the Institution of Mining and Metallurgy, promises to be of considerable technical interest. He has for a long time been investigating the precipitation of gold from cyanide solutions by contact with graphitic schist. Though he has not been able so far to find a means of preventing this transference of the gold from the quartz of the vein to the schist of the gangue during treatment in the cyanide plant, he has discovered that a solution of alkaline sulphide will re-dissolve a large proportion of the precipitated gold. Some practicable means of recovering the gold from the sulphide solution will have to be devised. Mr. Feldtmann suggests contact with metallic copper. The fact that the precipitate on the

graphite will not re-dissolve in fresh cyanide solution tends to show that the gold exists in the combined state and not free. We are not aware that alkaline sulphides have been previously suggested as solvents for gold in connection with processes for the extraction of the metal from ores, but the property has been used in argument by economic geologists, notably Skey, Egleston, Becker, and more recently Lenher, for the purpose of explaining the migration of gold in ore deposits.

THE ANNUAL meeting of the Institution of Mining and Metallurgy was a gratifying function in many ways. The report of the Council passed in review the chief events of the year. The granting of the Royal Charter, and the devotion of their services to the country's call on the part of so many members, are the cause of justifiable pride. The income and the capital account both mount steadily. The president and other speakers uttered words of encouragement to members to do all in their power, in their collective and personal capacities, to maintain and even improve the high tone of conduct demanded by the public recognition of their aims and objects. The speeches of thanks to the retiring president, Dr. F. H. Hatch, and of welcome to his successor, Sir Thomas Kirke Rose, were not only felicitous, but sincere. As regards Dr. Hatch, we know him to have been a particularly able presiding officer, dignified, alert, and well-informed, yet modest withal. His successor delivered an inaugural address of high technological value, discussing the present methods of gold-refining, a subject of which, as chemist to the Royal Mint, he is naturally a past master. Many points in the address aroused the keen interest of his auditors, notably the account of the way Dr. W. A. Caldecott rose to the occasion when the Government of the Union of South Africa asked for a method of refining Rand gold as a preliminary to the re-establishment of minting operations at Pretoria, when the shipment of this gold to England was suspended on the outbreak of war. The president's analysis of the comparative advantages and costs of the several processes now used in Europe, America, and Australia was presented in an attractive manner. But perhaps his account of the origin of the electrolytic method provided the greatest stimulus. His evidence that the electrolytic method of gold-refining was invented by an Englishman years before Wohlwill introduced it in Germany will form a standard record for the archives of metallurgical literature. It provided Sir Thomas Holland with an opportunity for one of his characteristic touches of humour, when, in thanking Sir Thomas Rose for his address, he said that he hoped the claim for priority would cause no ill-feeling between the two countries. As Sir Thomas Holland also said, let us hope that the new president's term of office will be rendered famous by the conclusion of a lasting and honourable peace among the nations.

Flotation in North America.

The slowness of the American engineer to appreciate the practical value of the principle of flotation as applied to concentration problems has always struck his English and Australian confreres as anomalous. When the selective buoyant action of oil and bubbles was first demonstrated by Miss Everson, of Denver, in 1885, metallurgists were not interested, and though the successful application of subsequent inventions along this line at Broken Hill was due in no small degree to the efforts of two other Americans, Messrs. H. C. and T. J. Hoover, the method of concentration attracted little serious attention in the United States, in what we may call the early days. During the last two years this attitude of aloofness has entirely disappeared, and none is so keen nowadays as the American engineer for the investigation and application of the process. In our last issue we

made brief reference to the adoption of the Minerals Separation process at Anaconda, and in the present issue we quote in 'Précis of Technology' the statement on the subject made by the metallurgical manager, Mr. Frederick Laist. The adoption of flotation at Anaconda at this juncture is all the more notable, seeing that the metallurgists had already commenced the construction of a roasting and leaching plant for treating the tailing, which at present contains from 13 to 14 pounds of copper per ton. The final decision for the adoption of the leaching process was arrested a year ago on the advice of Dr. L. D. Ricketts, who recommended the trial of the Minerals Separation process. The result of the trial has been so satisfactory that a flotation plant with a capacity of 15,000 tons per day is to be erected for the treatment of the whole of the current tailing, and the use of the leaching plant is to be diverted to the treatment of 15,000,000 tons of accumulated tailing. The serious nature of this modification of concentration practice at Anaconda may be gauged by the fact that it involves an entire change in smelting practice, for the product will be unsuited for the blast-furnace and reverberatories are to be built instead, and an expenditure on new plant of six million dollars. In the concentration plant, the jigs are to be removed, and their place taken by roughing tables, which will produce a concentrate and coarse tailing. The latter will be re-ground in pebble-mills to pass 60-mesh, and will be sent to the flotation plant. The slime-tailing from the multiple-deck round tables will also be treated by flotation. The flotation plant will consist of twenty-four machines, each with a capacity of 600 tons per day. During the tests, a concentrate containing 8% copper was obtained, with 0·1% or less left in the tailing, and the total recovery of copper from the ore was raised from 78 to 91%. Seeing that the yearly output of copper is 120,000 tons, the aggregate increase of yield represented by this improvement in extraction amounts to no less than 20,000 tons. The total cost of treatment will be reduced when the whole of the remodelled concentration and smelting plant is in operation. But the immediate advantage gained by the increase in recovery and the reduction of cost is not all, for the greater margin between cost and yield also means that vast quantities of low-grade ore will be brought into the profitable reserves. That the Anaconda company is willing to contract with Minerals Separation despite the unsettled state of the patents has caused some comment and speculation as to the terms of agreement. The relative standing of the Minerals Separation patents and those of Mr. James M. Hyde, under which the Butte & Superior plant is being worked, has not yet been settled, and the appeal before the Supreme Court at Washington is not likely to be decided for some months. Another alleged infringer is Mr. J. M. Callow, of Salt Lake City, whose process was described in our issue of August last. The chief user of his process, the Miami Copper Company, of Arizona, is being sued by Minerals Separation at Wilmington, Delaware. A number of other companies besides the Anaconda have made contracts with Minerals Separation, such as the Inspiration, Consolidated Arizona, Engels, Mountain Copper, Britannia, Cuba, Chusi, Atlas, and the Butte mines controlled by Mr. W. A. Clark. This widespread interest is largely due to the publication of accurate information with regard to the process by Mr. Theodore J. Hoover in his book 'Concentrating Ores by Flotation,' and also to the personal activities of Mr. E. H. Nutter, of Minerals Separation. A specially interesting application of the flotation principle is in connection with the Butters Salvador gold and silver mines. Mr. Charles Butters has a working agreement with Minerals Separation, and at his laboratory at Oakland, California, is making extensive studies

with a view to the application of flotation to the concentration of gold-silver ores. He has already obtained excellent results in many experiments, and has become assured of an important increase in recovery at the Salvador mines. A large number of companies other than those mentioned are experimenting with flotation independently of the owners of patents, with a view to investigating the applications. For instance, the controllers of the Butte & Superior company have also work in hand at Garfield, Utah, and several of the companies belonging to the Guggenheim group are actively engaged in making trials. The process is applied successfully in the treatment of gold, silver, copper, lead, and zinc ores. Whatever the eventual outcome of litigation, it is certain to be widely adopted in all the great mining districts of the United States, Canada, and Mexico, and the lack of interest in the early days will be atoned by an unbounded enthusiasm in the future.

Great Cobar.

Shortly before our last issue went to press, the receiver for the Great Cobar company issued a brief circular describing his proposals for the future conduct of operations. At the subsequent meeting of debenture-holders, these proposals were discussed, and further information as to the conditions and prospects was given. In our hasty reading of the circular, we obtained the impression that the proposals for the future working of the property assured a return of all the debenture capital instead of only a portion of it, and we thereby gave an erroneous interpretation of the facts as presented by Mr. W. Pellew-Harvey, whose report formed the basis of the receiver's proposition. The present position of Great Cobar is worth examining in some detail, especially in connection with its past history. It may be safely said that never has a great ore deposit yielded such poor results to English shareholders as the Great Cobar copper mine in New South Wales. Something indeed must be radically wrong if a mine can be sold to an English Company for over £1,000,000 and subsequently produce 30,000 tons of copper and 100,000 oz. of gold—a gross output worth over £2,200,000—without doing much more than pay interest on debentures. The deposit was discovered in 1869, and the first load of ore was despatched in 1871. Until 1906 the mines were operated by Australian owners, who extracted 50,000 tons of copper and made large fortunes. In that year the properties, including the Chesney mine bought in 1904, were sold to the present London company, the purchase price being £800,000 in cash and £206,000 in shares and debentures. Funds for the payment of the purchase price and promoter's profit and for the provision of working capital were raised by issuing debentures for £550,000 and 130,000 shares of £5 each. We will not now recapitulate the many misadventures in connection with the administration, the treatment plant, the estimation of ore reserves, and the methods of mining that have characterized the history of this company. Suffice it to say that just a year ago Mr. C. G. Klug, who had shortly before been appointed manager on behalf of Bewick, Moreing & Co., reported that the mine showed only a small margin of profit and that the workings were dangerous. In the absence of any possibility of providing sufficient money to make the workings secure, operations were suspended, and the company was placed in hands of the receiver appointed by the English courts on the petition of certain debenture-holders. Mr. Arthur F. Whinney, the receiver and manager appointed by the Court, supported by a committee of debenture-holders, eventually commissioned Mr. W. Pellew-Harvey to proceed to the property, make an examination and prepare a report. Mr. Pellew-Harvey had joined the board of directors in 1911, shortly after the Cobar Gold

Mining Company was absorbed, this absorption having been effected for the mutually advantageous purpose of treating the ores of the two mines together, the Great Cobar ore high in iron and the Cobar Gold ore high in silica. He had been sent by the Board in 1913 to make investigations on the spot, as the affairs of the company were beginning to cause serious anxiety, but he was not instructed to make an independent examination of the ore reserves, nor was he permitted to do so. We venture to suggest that if the mine had been subjected to a thorough sampling at this time much of the subsequent trouble would have been avoided. However, on his last visit, Mr. Pellew-Harvey was on the mine from August to December 1914, and made an exhaustive examination, in which he was assisted by Messrs. E. Hogan Taylor, G. A. Laird, and G. A. More, in connection with the mining problem, and by Mr. H. St. J. Somerset, of Mount Morgan, as regards the smelting proposition. His complete report, based on his own observations and on those of the engineers named, has unfortunately not been published, but his main conclusions have been made known. He estimates the ore available at 871,000 tons averaging 2·42% copper and 0·48 dwt. gold per ton in the Great Cobar, 550,000 tons averaging 2·4% copper and 0·9 dwt. gold in the Chesney, and 280,000 tons averaging 1·7% copper and 6·6 dwt. gold at the Cobar Gold mine. These figures do not include ore left in the workings above the 4th level in the Great Cobar. Allowing for this deduction, and for the ore extracted during the period between his two visits and the ore locked-up in the creep-zone, his estimates are not greatly below those made by the general manager two years ago. According to his recommendations, smelting should be resumed on the basis of 650 tons of Great Cobar ore, 200 tons of Cobar Gold ore, and 50 tons of selected Chesney ore, a total of 900 tons per day. From this mixed ore, it is calculated that the production will be 16·88 tons of copper and 86 oz. of gold per day. The tonnage treated in the furnaces will be practically the same as before the stoppage, but the supply from the Chesney will be of a different nature. Before the stoppage, concentrate was shipped from the Chesney, but as the concentrating plant requires substantial costly alterations Mr. Pellew-Harvey considers it best to send selected ore averaging 3% copper and 3 dwt. gold to the smelters, and to postpone the question of treating the reserves of lower-grade ore. His calculations, based on the known supply of pyritic ore, provide for a smelting campaign lasting three years, during which time, with electrolytic copper at £65 per ton, a realized profit of £301,700 may be expected. From this must be deducted a sum of £212,900 required for the payment of Federal and State taxes, income tax, London and Sydney expenses, and for the cost of filling the stopes with the object of making the mine safe before work is commenced. The balance of £88,800 would be available for the redemption of debentures, of which £665,000 are now outstanding. At the end of the three years, if no further ore supply is found, he estimates that the plant and other assets would realize £63,700. We are not informed what the other assets are, but we regard the sale value of a three-year-old plant as somewhat problematical, as mining and smelting plants, especially the latter, rapidly deteriorate, and the question naturally arises whether a much larger sum could not be obtained by its sale at once than after three years of wear and tear. But accepting the figures in the circular, it appears that £152,500 is the value of the property to the debenture-holders, with copper at £65 per ton. It will be seen that the margin between cost and income is so small that the eventual result depends largely on the price of copper, for with electrolytic at £60 the profit of operation would

be nearly extinguished. On the other hand, a higher price such as that ruling at the time of writing would greatly improve the position. The question naturally arises whether there are any chances of further supplies of ore being discovered. Mr. Pellew-Harvey considers that, though development at depth presents little or no encouragement, much may be done in the way of lateral exploration, and the engineers who assisted him in the investigations have indicated the opportunities in this direction. In fact, recent cable advice is to the effect that further supplies of basic ore have been found in the South shoot, and that another basic orebody has been disclosed farther to the west. With a rise in the price of copper, the expenditure on improvements in the concentration plant at Chesney may be justified, with the object of beneficiating the low-grade silicious ore. These considerations, however, do not come before us at present, as they are only possibilities and have no bearing on the present financial position. The immediate question for debenture-holders to consider is the raising of £102,000, estimated by Mr. Whinney as being required for paying debts and meeting liabilities, and for undertaking the work of making the mine safe by means of stope-filling. The terms on which such a sum could be raised under present circumstances are sure to be onerous. The alternative of selling the property was also considered by Mr. Whinney and the committee of debenture-holders. After due inquiry they found that if this course was taken money would be required to rehabilitate the mine before a prospective purchaser would be attracted. In any case the chances of finding a purchaser appear remote, and in the meantime considerable expense would be incurred by the necessity of doing sufficient current work to satisfy the requirements of Australian mining law. All thought of a sale was, therefore, abandoned. The debenture-holders have agreed by a large majority to adopt Mr. Whinney's proposals to work the property in the manner outlined. It will be seen that the scheme contains no reference to the shareholders or to the chance of their recovering any of their money. The number of shares issued amounts to 186,542, and as their denomination is £5, the cash represented by the shareholdings is £933,710. This would appear to be inevitably lost. To sum up, we consider that the justification of the scheme depends chiefly on the terms on which the additional funds can be raised. From the point of view of the outsider, the scheme is not attractive, as Mr. Whinney admits, so it is impossible to expect anybody to subscribe the funds required other than those already financially interested in the company. If the terms upon which the required funds can be raised prove prohibitive, the debenture-holders will lose nothing by holding the property. Probably £6000 a year would serve to protect the titles and maintain the plant and machinery. Then it would be policy to wait for the next copper boom and better financial conditions, when the inevitable promoter is sure to appear, and he will want nothing better than assured ore reserves and a long history of production, neither of which will be diminished by time.

The Cottrell Patents.

The correct or most advantageous policy to pursue in the exploitation of a new process for the benefit of the inventor, his friends, and the prospective users has often formed, and will continue to form, a subject of discussion in both professional and business circles. Too often the inventor or owner has such exaggerated opinions of the importance of his process that he seeks to take the user by the throat, extract a stiff royalty, and sit for ever thereafter in easy idleness. Naturally such a cold-hearted attitude arouses the spirit of counter-attack on the part of the industry involved. Some corporations impudently ap-

propriate the process bodily and leave it to the holder of the patents to obtain redress as best he can. Others seek by scientific research to establish a modification sufficiently definite to provide the basis for a valid argument before the courts. All these troubles are due to the mistaken notion on the part of the inventor that one new idea is sufficient to last for a life-time, instead of its being only an incident in his career. The brains and energy of an inventor are a greater asset than the process that he invents, and the motto of the inventor should be: 'Service, more service, and still more service.' The inventor imbued with true scientific spirit, and without the lust of power and greed of gold, will be content to continue his researches, happy in his occupation, and receiving due pecuniary recognition for the services rendered by him from day to day, or year to year. Faraday, one of the most original thinkers of all time, was modest in his demands to an abnormal degree, rooms at the Royal Institution and a salary that would be reckoned nowadays as beggarly by a second-class clerk being sufficient to satisfy his needs and aspirations.

In recent days we have known nothing more admirable than the attitude of mind of Dr. Frederick G. Cottrell, the inventor of the electrostatic method of precipitating fume. Cottrell, as a youth, was in comparatively poor circumstances, but nevertheless was enabled, by the liberality of an American college endowment, to become an alumnus of the University of California. After completing the course of study with credit, he proceeded to Leipzig, where he was engaged in chemical research under Ostwald. German methods of scientific examination were too monotonous for his enterprising mind, and on his return to California he determined to make a study of a subject that bristled with difficulties, that is to say, the removal from the air of solid and liquid particles that are too minute to settle by themselves. Sir Oliver Lodge had, in earlier years, proposed to clarify the London atmosphere of fog and dust by means of an electrostatic discharge, and Mr. W. Maynard Hutchings had attempted to settle lead-fume at Walkers, Parker & Co.'s smelting works in North Wales by similar means. Neither of the experiments had indicated that this proposed application of electricity would come within the bounds of commercial possibility. We believe that many people in America predicted the same fate for Dr. Cottrell's investigations, and that for a long time the smelters and the power-engineers regarded him merely as an impracticable scientist. His experiments on a small scale at the University attracted the attention of Dr. Harry East Miller, a chemical engineer at San Francisco, who was at that time seeking some satisfactory method of obviating the smelter-fume nuisance, and at his invitation the investigations were transferred to his own laboratory. Subsequently Emanuel S. Heller, a prominent lawyer and business man, took an interest in the work, as also did Professor Edmond O'Neill, of the University of California. Under their advice the Western and International Precipitation Company was formed in 1907 to continue the research. We need not on this occasion give a description or enter into any discussion of the Cottrell process, for we published details in our issues of October 1911 and April 1914. It may be said, however, that it has worked wonders in settling both solid dust and liquid globules, so that at the smelters the metallic fume and the sulphuric acid are readily removed from the gases leaving the furnaces. The process is also beneficial in removing the carbon particles of black smoke, and for settling dust formed in many manufacturing industries. It is not so much the technology of the subject that interests us on this occasion, as the beneficent uses to which the royalties accruing to the patent-holders have been applied. Dr. Cottrell and his friends decided to offer these royalties to the Smithsonian Institution

at Washington, to constitute a fund for the encouragement of scientific research, and eventually a separate organization was formed, in 1912, called the Research Corporation, for the purpose of assuming the proprietorship of the patents and of administering the moneys, under the direction of the Institution. Already a sum of over $120,000 has been received by the corporation from the royalties. The services of Dr. Cottrell have been secured by the United States Bureau of Mines, where his position will be that of 'physical chemist.' Dr. Cottrell has benefited the community in two ways. He has not only created a method for abolishing a public nuisance, but he has devoted his profits to the subsidizing of further scientific research. Incidentally it is worth noting that the vesting of patent rights in a scientific institution will tend to remove any possible inclination on the part of users to evade the patents, and at the same time this semi-public ownership will ensure the attainment of an equitable basis for the business transactions. The scientific instinct and the generous spirit of the inventor, as exhibited by his persistent effort and his agreeable methods, have received the approbation of the scientific world, and the value of the man as well as the value of the patents has been established.

Radium and Plant-Life.

Science is so often the plaything or the victim of the charlatan, that discoveries and novel theories and their proposed applications are, on occasion, warrantably eyed askance. Especially is this the case with those branches of science that border on the occult. Good reason exists for expressing dissatisfaction with some of the propositions introduced to the notice of the public for the exploitation of radium, and for inquiring closely into the character and temperament of their sponsors. Under these circumstances it is a pleasure to draw attention to the investigations conceived and conducted with true scientific spirit by Mr. Martin Sutton on the effect of radio-active material on plant-life. Mr. Sutton is a commercial botanist of international repute, and his experimental station at Reading has repeatedly proved its value in connection with agricultural and horticultural research. We, therefore, treat his report with respect. The experiments described by him covered a wide range, and included studies of the effect of radio-active material on both the germination of seeds and the increase in the size and rapidity of growth of the plant. Three classes of material were used: ore containing the equivalent of 8 or 9 milligrammes of radium bromide per ton, residues from the radium-extraction works still containing 1·8 milligrammes, and pitchblende. These were added to the soil in proportions varying from 1 : 12 to 1 : 2240, being either evenly mixed throughout the soil or distributed in a layer at the bottom of the boxes. At the same time, for the purposes of comparison, similar experiments were made in boxes containing plain black garden soil, and soils enriched with many varieties of manures and fertilizers. The general results tended to show that the addition of radio-active matter hastened growth as compared with the results in the plain black soil, but that as a rule the fertilizer adapted to the requirements of the particular plant did better than the radio-active matter. In the case of rape, a plant extensively cultivated as a food for sheep, and for the oil that can be expressed from its seeds, the growth under the influence of radio-active matter was luxuriant. The experiments were inconclusive as to the best proportion of radio-active matter to employ, but in most cases small amounts of poor residue appeared to be as effective as larger quantities of ore or of pitchblende. If these deductions with regard to quantity are confirmed, the cost of the system of forcing would be greatly reduced, as the residue would be obtainable at only a fraction of the price demanded for the ore.

The wisdom of substituting so expensive a material for the cheap and plentiful fertilizers of commerce may be questioned, though Mr. Sutton reminds us that as radium lasts for a thousand years the ultimate cost of the supply would be trifling. We shall follow his further experiments with interest, for any investigation that promises to assist the activity of the miner is our particular care.

Mining and Military.

This is a free country and compulsory military training is supposed to be unpopular. That devoted and brilliant soldier, Lord Roberts, was flouted by the politicians when he advocated, as the result of the experience of a lifetime, the adoption of universal service. Had his advice been taken, Germany would have not dared to rush into the present war. The lesson of our unpreparedness has, however, not yet been learned by those in control of the education of the rising generation of this country. The same opposition to military instruction exists now as before the war. Baden Powell wished to benefit his country by the experience he gained in the South African war, by inaugurating a scheme intended as a preparation for military training, a scheme inculcating discipline, vigour, and self-effacement among the boys. He was met by the execrations of the peace party, who, though they had no objection to drilling, marching, and carrying the survey-staff, inveighed against the recognition of the existence of such things as guns and bayonets. In spite of the lesson of the present war, a hundred times more grave than that in South Africa, the same party in control of our schools shows the same opposition to military training. We take it, therefore, as a duty to our country to express our own opinions on this subject, as they affect the branch of education in which we are more particularly interested, in the hope that our views will be echoed in such a way as to have some influence in the councils of the Government. As Lord Roberts and Baden Powell said, it is not so much the desire to train the men to kill an enemy, as to inculcate the principle of self-reliance, obedience to orders, and ability to command. From our own experience with young men about to enter the profession of mining we agree entirely with these views. We should like to see military training made compulsory in every technical school in the United Kingdom and the Overseas Dominions, not only with the idea of preparation for war but as a valuable training for a successful administrative career. Promptness, system, accuracy, and all the other attributes that can be grouped under the word 'discipline' can be attained by military training. The full benefit cannot be derived from summer encampments or intermittent drills. It is necessary that regular military units should be formed, the first-year men serving as privates, and the officers being picked from the most efficient men in their last year. Most of our schools are in need of funds, and it would not be too much to ask the Government to grant a suitable subsidy to the schools that have an established military training, and to appoint an approved military instructor. The country's return for the investment would be handsome, as a constantly rejuvenated corps of men would be provided, having the necessary preliminary training, the absence of which is now retarding the completion of Kitchener's army. An hour's drill every morning and a weekly lecture on military subjects are all that would be required. If the improvement in physical condition alone were to be considered, the scheme would be justified, but we go further and believe that many of our young men would find their way to success expedited when they realize the importance of discipline. To have your orders obeyed you must know how to take them. *Qui nescit obedire nescit imperare.* You cannot expect to administer well and with equity until you have a thorough knowledge of the limits and

capacities of those who take your orders. The value of a complete military organization of young men lies in the training to be gained in carrying-out orders given by men of the same social standing. If a young officer can keep a company of his own school-mates under strict military control and retain their goodwill and respect, he will have attained a power that will serve him well when he assumes an administrative capacity. In our experience we have known too many young men who have lost excellent chances of advancement because they had not learned to take orders gracefully. Yet another aspect of this military training for students at our technical colleges remains to be noted. More and more does war pass to the engineers. The handling of artillery, the digging of trenches, the management of motors, the warfare in the air, are all more efficiently done by those with a knowledge of mechanical science. Therefore engineers should loyally place their special talents at the service of their country, and by adopting the preliminary military training in their colleges make those talents more immediately valuable.

Government Assistance to Industry.

Those in touch with industrial chemistry were not surprised at the failure of the Government's scheme for establishing a British dye industry. For one thing, the allowance for research was hopelessly inadequate. The necessary amount of highly skilled scientific labour that is required for the discovery of new colours and of improved methods of manufacture is evidently not appreciated by the Government. The success of the German manufacturers of dyes, drugs, and other products of the coal-tar derivatives is due to the untiring energies of an army of scientific chemists willing to work long hours and for low pay. Unless a correspondingly adequate subsidy for research is made available for the British project, the new industry will soon become stagnant. A much more important objection to urge against the Government's scheme is the entire absence of any guarantee that the enterprise will be protected, after the terminatiom of the war, against renewed German competition. It is true that the dyers of cotton and woollen goods in the north of England and Scotland desire to have a supply of dyes in substitution for those that have been obtained hitherto from Germany, and that their needs are pressing, so that they may find it to their advantage to back, at any cost, a scheme that promises to give them an immediate supply of dyes, and so prevent an utter collapse of some of the staple industries of the country. Such a provision of capital would be in the nature of an emergency measure. But the founding of a permanent British business is an entirely different problem. Those willing to provide the money on ordinary commercial terms demand some guarantee that the business should be continuous and permanent. The Government's invitation to the public to subscribe capital without such a guarantee indicates a woeful want of knowledge of ordinary business requirements. A few months ago the establishment of a zinc-smelting industry in this country was mooted by those interested. Inquiries were made of the Government authorities, with a view to ascertaining the extent of protection to be expected, and an attempt was made to have the status of present contracts settled in the courts, but in neither case was anything but the cold comfort of theory or of law given to the enterprising parties. Matters went no further than this tentative stage, but no doubt if the barrier had been passed and a business proposition formulated, the same doctrinaire difficulties would have been placed in the path of the capitalists as are now apparent in connection with the aniline dye scheme. The present time provides an opportunity for the Liberal party to modify its terms of subserviency to the unrestrained principle of free trade, just as it has manfully shattered the old

fetish of peace at any price. 'Protection' in the hands of the Conservative party might not be acceptable to the public, because of the suspicion that the legislation would be applied for the benefit of the masters; but, on the other hand, under the guidance of the party claiming to be in closer sympathy with the workers and the community generally, there could be no doubt that a wise application of the principle would often prove beneficial. A tariff is required only high enough to protect the home industry, but not so high as to enrich the capitalist, or to unduly raise the prices of the commodity. We appeal to the political party at present in authority to show due regard for the requirements of the business man, and to demolish some of the economic gods which, after all, are only of their own creation.

German Genius.

It is the proud boast of the German people that theirs is the preponderating, and even overwhelming, share of the world's genius. The legitimacy of this claim depends on which of the two definitions of the word 'genius' they have in mind; whether genius is, in the words of Bulwer Lytton,

"The power to change the unknown to the known,
"The unseen to the seen,"

or, to quote Thomas Carlyle, the "transcendent ability of taking trouble," a saying popularized later by Whistler as the "infinite capacity for taking pains." If we adopt Carlyle's definition—and he was under the domination of German philosophy—we are willing to give the palm to the Germans. No nation has ever exhibited such an inclination for careful and patient work, in business and in science, and her substantial reward has been great. But the other type of genius that creates new thoughts, provides new applications of the forces of nature, and pierces the secrets of the universe is oftener found among the Anglo-Celtic and Latin races. Inventions that revolutionize the conditions of every-day life, recognitions of natural laws and their interpretations, have not as a rule had their birthplace in Germany. In other words, novel ideas are not characteristic of the Teutonic mind.

Take the realm of mathematics as an instance. Algebra originated among the Arabs, and was finally established in Italy and France, notably by Vieta. Geometry was brought to perfection by the old Greek philosophers, and algebraic or co-ordinate geometry by Descartes. Logarithms were invented by a Scotsman, Napier, and perfected by Briggs, an Englishman. A regrettable incident occurred in connection with the claim to the principle of differential calculus, Leibnitz, of Hanover, anticipating Sir Isaac Newton in the publication of his thesis, though the two had compared notes for several years previously. Passing to chemical and physical sciences, we find that the undulatory theory of light was evolved by Huyghens, a Dutch mathematician, who developed also the principles of polarization. Brewster and Wollaston first penetrated the mysteries of the spectrum, and Fraunhofer, Bunsen, and Kirchhoff reduced this method of analysis to an exact science. From the earliest days Germany has been the home of chemical research, but modern chemistry was founded by English and French chemists, Priestley, Cavendish, Lavoisier, Dalton, and Humphrey Davy. To Newton is due the law of gravitation. Joule enunciated the principle of conservation of energy and the mechanical equivalent of heat. The art of photography was founded by Daguerre and Talbot, who recognized the possibility of the application of the chemical action of light for the production of pictures. Aniline dyes were discovered by an Englishman, Perkin, but their manufacture gradually passed into the hands of the Germans, whose temperament is better suited than ours to the continuous, detailed, and even drudging research that is necessary in this industry. The electric current was first noted in Italy by Volta and Galvani, and its appli-

cation and science were advanced by Faraday, Franklin, Ampere, and Arago. Sturgeon invented the electro-magnet. The dynamo was developed by Gramme, Edison, and Hopkinson. Electro-chemistry was founded by Faraday, telegraphy by Wheatstone and Morse, ocean telegraphy was rendered possible by Lord Kelvin's inventions. Oersted, of Copenhagen, first observed the effect of the electric current on the magnetic needle. Ohm, a German scientist, did important work in defining the relations of current and resistance. The incandescent electric light was developed by Swan and Edison, and improved by the Germans, who succeeded in making a cohering filament of refractory metal. Bell invented the telephone. Berzelius, a Swedish chemist, discovered the glow of zirconia, thoria, and ceria, nearly a hundred years ago, and an Austrian, Auer von Welsbach, seventy years afterward perfected the lighting system based on this property of the rare earths. Becquerel, a French chemist, established the principle of radio-activity, and his pupils, the Curies, detected and separated radium. Röntgen found that what he called the X-rays, emanating from the Crookes tube, would pass through solids and affect the photographic plate. The periodic law in chemistry was due to Newlands, an Englishman, and to Mendelejeff, a Russian chemist. The corpuscular theory of matter was evolved by Sir Joseph J. Thomson.

In general engineering, Newcomen and Watt made the steam-engine, Fulton built the first steamer, Trevithick and Stephenson the first locomotives, and Parsons the first steam-turbine. Some people suppose that to Germany belongs the honour of introducing internal-combustion engines; but these were first used in France, and Beau de Rochas invented and patented the 'four-cycle motor' long before Otto attached his name to it. In mining machinery the stamp-mill, the jig, and the buddle were first used in Germany. Frue and Wilfley, two Americans, introduced the continuous vanners as substitutes for the cruder buddle. Whatever difference of opinion may exist as to the originator of the principle of concentration by flotation, it is at least agreed that no German helped in its evolution. In modern metallurgical processes it is interesting to record that Bessemer, the nominal inventor of the process bearing his name, was of German parentage. His experiments were failures until Robert Mushet of Sheffield showed him how to regulate the amount of carbon in the steel. An Englishman, Thomas, invented the process that made it possible to utilize German, French, and Swedish iron ores. John Hollway and Paul Manhes revolutionized copper-smelting by the introduction of the converter. The cyanide process owes nothing to Germany, and everything to English and American metallurgists. Of modern explosives, Sobrero invented nitro-glycerine, and Alfred Nobel, the distinguished Swede, made its use safe by mixing it with infusorial earth. Gun-cotton was invented by Schoenbein, of Bâle, and the mixture of nitro-glycerine and gun-cotton, used nowadays in warfare, by Nobel, Abel, and Dewar. Lastly, we look back through the records of progress in geology. The foundation stones of geology as a science were laid by William Smith and James Hutton, though, owing to his recognition of the practical importance of metalliferous minerals, some might be inclined to award this honourable distinction to Werner, the professor of mining at Freiberg, who flourished at about the same time. Among other geologists Sir Charles Lyell and James Dwight Dana stand pre-eminent.

Space prevents us going further. Otherwise we could discuss aeroplanes, engines of warfare, machine-tools, wireless telegraphy, the electric furnace, and many other branches of engineering and physical science; but the verdict would be the same, that German genius lies in persistent mastery of detail rather than in brilliance and courage.

PERSONAL.

J. A. AGNEW has left for Nicaragua.

H. FOSTER BAIN sails from New York for London on April 17.

C. P. C. BERESFORD left for the Prestea Block A mine, Gold Coast, on the 7th inst.

BRAXTON BIGELOW has been with the American Ambulance Corps in France, and has now been attached to hospital work in Serbia.

G. H. BLENKINSOP has joined Enslin's Horse and left Johannesburg for German South West Africa on February 15.

E. T. BORLASE has a commission in the Royal Garrison Artillery, Scottish Command.

JOHN C. BRANNER has resigned as president of the Leland Stanford Jr. University.

J. VAN DEN BROCK, manager for the Billiton Tin Company, is in London superintending ore tests.

STANLEY C. BULLOCK is temporarily in charge of the Poderosa copper mine, Chile, during the absence on leave of the manager.

GEORGE B. BUTTERWORTH is manager of the Whim Well copper mine, West Australia.

J. M. CAIRNS left on April 10 to take the position of resident manager of the Baluchistan Chrome Company, Quetta.

A. R. CANNING is here from Nigeria.

FRED CLOSE has gone to the Caucasus.

JOHN PALMER COSGRO has been appointed chief engineer and sales manager for the Wilfley Machinery Company.

ARTHUR CROWFOOT has been appointed manager of the concentration department of the Arizona Copper Company's mines at Morenci.

ALLAN A. DAVIDSON left for Northern Nigeria on March 27 on the *Falaba*, and was among those rescued.

CLEMENT DIXON joined the Rhodesian Defence Force on the outbreak of war. He served with the Imperial Forces during the Boer war.

G. W. EDWARDS has a commission in the 9th Border Regiment.

A. STANLEY ELMORE has left for New York.

P. R. EVANS is lieutenant in the Royal Field Artillery.

J. W. FETHERSTONHAUGH, manager of the Eldorado mine, Rhodesia, in home on holiday.

T. W. GILBERT is with the Royal Artillery.

WALTER GIVEN has been appointed director of the Karangahake School of Mines, New Zealand.

J. WENSLEY GRAY has a commission with the Yorkshire Regiment at Rawal Pindi, India.

C. F. HEATHCOTE is on his way home from Tasmania.

J. A. LEO HENDERSON left for Canada on March 27.

G. G. HEWITT is serving with the Imperial Light Horse in South Africa.

E. R. HINKLEY and HOWARD NORSWORTHY have left for the Kasai diamond fields in the Belgian Congo.

ROSS B. HOFFMANN is in London.

P. K. HORNER, general manager of the Union Minière du Haut Katanga, is in London.

J. POWER HUTCHINS is here from Petrograd.

DUDLEY J. INSKIPP has gone to the Mawchi tin and wolfram mine in Upper Burma.

D. C. JACKLING is inspecting the properties of the Alaska Gold Mines Company, at Juneau.

AUGUST LEDOUX, lately professor of mineralogy in the University of Brussels, has joined the staff of the University of Toronto.

ROBERT J. MORGAN has returned to Spassky.

EDGAR PAM has been elected president of the Transvaal Mine Managers' Association.

L. RADKIN, lately manager of the Sandoval Zinc Co., Illinois, passed through London on his way to Ekibastus, Siberia, where the zinc-smelter of the Irtysh Corporation is being built.

JOHN E. V. RATHBONE, son of Edgar P. Rathbone, is with the Officers' Training Corps, Lincoln's Inn.

PETER DE P. RICKETTS and JOHN H. BANKS have dissolved partnership as Ricketts & Banks and in future will conduct their respective practices independently.

J. MITCHELL ROBERTS is proceeding to Korea to supervise the erection of plant for the Chosen Gold Mines Limited.

L. C. ROGERS is here from Chuquicamata, Chile.

ARTHUR J. RUSSELL has returned from the Tolima Company's mines, Colombia.

C. A. SMITH, lately mine superintendent for the Caucasus Copper Co., is volunteering his services in the Rotterdam office of the Commission for Relief in Belgium.

A. B. SNOW and W. W. WEBSTER have entered into partnership with headquarters at Tongkah, Siam.

ROBERT C. STICHT has been elected president of the Australasian Institute of Mining Engineers.

W. W. VARVILL has a commission with the Fourth Northumberland Fusiliers.

D'ARCY WEATHERBE has left for Canada.

RUSSELL B. WOAKES has received a commission with the 2nd Sappers.

METAL MARKETS

COPPER.

Average prices of cash standard copper:

Mar. 1915	Feb. 1915	Mar. 1914
£66. 5s. 5d.	£63. 12s. 6d.	£64. 8s. 1d.

The market has advanced steadily during March, and the price of standard copper has been enhanced £6 per ton. Stocks in this country show a continuous fall since the outbreak of war, a movement that is likely to be accelerated by the acute scarcity of shipping facilities. The expectation that American stocks would tend to accumulate is unlikely to be realized, as prices there are increasing as they are here. Producers are becoming more independent, and are obtaining 16 cents f.o.b. for electrolytic copper, equal to £77 here. The American output is being increased, and some of the mines that had been closed on the outbreak of war have reopened. The scarcity of refined sorts has become acute through the enormous demand for war and the holding-up of cargoes shipped to neutral countries by the activities of the British fleet. While no decline in consumption need be anticipated at present, the situation nevertheless merits attentive watching. The speeding-up of output, the release of detained material, and the removal of the freight difficulties will bring relief to the market. Speculation, fortunately, is dormant, and is discouraged by dealers, so that no violent reaction need be anticipated. On the whole a further moderate rise seems assured.

TIN.

Average prices of cash standard tin:

Mar. 1915	Feb. 1915	Mar. 1914
£180. 10s. 10d.	£156. 14s. 6d.	£174. 0s. 1d.

Tin has at last been put on the list of contraband, and the export is prohibited without licence. In consequence the course of the market has been wild. One result is the disappearance of the heavy premium on spot metal in London, and another the enormous premium on spot metal in New York. Prices have become bewildering in their instability. The authorities are no doubt doing all they can to give reasonable facilities to exporters both in England and the Straits, but the effects of the regulations are not yet understood by traders, and until they are, wide fluctuations will continue. Welsh tinplate mills are handicapped by the scarcity of fuel, and by delays on the railways, and the whole trade is inconvenienced by the impeded discharge of steamers. A brisk business has arisen to Russian ports, and there is some Italian inquiry. The tonnage afloat to America is inconsiderable, and a heavy demand for spring shipment is anticipated. Buyers have been discouraged by the fluctuations on the London market. Business with the East has been hindered by delays in cables. Prices there have ruled well above London parity. Fair parcels of Banca and Billiton are now arriving or in course of shipment.

SPELTER.

Average prices of good ordinary brands:

Mar. 1915	Feb. 1915	Mar. 1914
£44. 2s. 7d.	£39. 16s. 4d.	£21. 7s. 9d.

Prices show little variation, and toward the end of the month, following the lower quotations issued in America, the official marking showed a moderate decline. These quotations reflect only the forward price, however, as supplies for early delivery are practically unobtainable. Consumers are heavily handicapped by the scarcity of freight. French buyers have paid pounds above the English parity. Galvanizers complain that orders are withheld owing to the high price of raw material. In spite of contrary expectations, there seems to be no possibility of increasing the output. The demand for high-grade sorts for munitions can only be met with difficulty, almost any price in reason being paid for whatever can be procured.

LEAD.

Average prices of soft foreign lead:

Mar. 1915	Feb. 1915	Mar. 1914
£21. 17s. 8d.	£19. 3s. 7d.	£19. 2s. 3d.

Prices have been ruled mainly by the freight situation, for while stocks in Spain, Australia, and America are adequate, difficulties in finding means of transport have been considerable. The situation threatened to become acute, and the price in London rose to over £23, but the engagement of American freight eased the market. Freights are now lower, and it is hoped that the relief may be permanent. Demand is strong, especially in European government quarters. Export is brisk. The American price is now 4·20 cents per pound.

OTHER METALS:

Quotations on April 8: Antimony, £80 per ton; nickel £185 to £200; aluminium, £91; quicksilver, £11. 15s. per flask; platinum, 185s. per oz.; silver, 23½d. per standard ounce.

SPECIAL CORRESPONDENCE

MELBOURNE.

The Metal Markets.—The position of mining in connection with the industrial metals has changed for the better during the past six weeks or two months. Arrangements have been made whereby the Broken Hill Proprietary has been able to market the lead and silver of some of the Broken Hill companies for which it now smelts. Preference is doubtless given to the product of the company's own mine, so far as priority of sales goes, but the broad fact is that a portion of the metals produced by the other mines of the Barrier district is now able to reach consumers in the East and in Great Britain. No one knows who is entrusted with the handling of the Proprietary Company's metals in Great Britain except the gentleman who was appointed by the Federal Government to frame its dossier for the authorities and the members of the Cabinet. His work took longer than was expected, but as most people surmised, the information placed before the official directed to make the examination enabled him to certify that the board had no dealings with enemy subjects. Just about the same time there was published here the names of the big German metal firms that have subscribed capital to a company to buy, from whatever source possible, metals for the use of their country during the war. There is no consideration of 'reasonableness' in this class of patriotism. Even though the names of members of German houses connected with our metal trade figure among the list of contributors to this War Metals Company, they will use the network of their world-wide organization to uphold their nation in conflict. A policy of this kind can only be met by counter-combination, and we feel that counter-combination must carry the war into every country in which German skill has established agencies. This is the form of 'reasonable patriotism' demanded here. So it is contended that to stimulate action, and to ensure a proper control being exercised over the trade in the future, the business agencies in London shall be moved into purely British hands. The marvellous thing is the absolute indifference of purely British firms to take up the business or to bring influence to bear on the British authorities that overt acts such as the creation of the War Metals Company shall be followed by the determining of all pre-war contracts to which the people interested are parties.

In this connection a trial of a metal agent in Australia for seeking to trade with the enemy subject has led to the publication of a great deal of interesting correspondence, showing the desire of German houses to retain their dominance in the metal trade of the Commonwealth. The New York correspondent of this agent wrote to the accused: "I have your private letter of September 8, and wish to say, in regard to all the arrangements made during the war, that our position naturally is a little different from yours. We have no patriotic obligations, and are not compelled by law to do or not to do anything. In regard to our relations with So-and-So, it is our decided intention and our firm resolve to do everything in our power to maintain the present organization and to lend a helping hand wherever we can to any of the branches, in order to help them hold their business and maintain the situation in the *status quo ante bellum*. While you are prohibited by law to do anything to help the enemy of your country, and while we do not expect you to break the laws of your country, we feel that you as well as Mr. Blank in Peru will hold together during these strenuous times and remain loyal to our friends. Particularly we wish to say there is nothing in any Royal Proclamation to the effect that you have to damage the enemies of your country in a business way." This is the voice of New York as to how the fighting for the control of the metal market of Australia should be done. The last sentence, in view of the way in which damage has been sought to be done to the business of British traders by German firms and financiers of various kinds, is a delicate piece of humour. Seeing that such advice is forthcoming from New York, would it not be well for the Board of Trade to keep watch and guard over the course

of Australian metals and trace every stage in the business? As has been already said, the prize is too valuable from the standpoint of share and metal market interests to be lost by the late holders without a struggle.

Taxes on Mines.—The way in which the Federal Government is poking its finger into the mining pie has not fully dawned on those who invest in mining. Some glimmering of the position may arise when the Commissioner of Taxation begins to assess the impost. Putting the case broadly, the desire of the Labour party is first of all to raise revenue, next to apply as forcibly as possible the principle of a tax on the unimproved values to all lands. Until recently this tax only related to land alienated from the Crown. Recently it has been desired to obtain a greater revenue, so the party voted for making Crown leases come under the tax. The majority of mining claims are held as leaseholds from the State under peppercorn rentals with a trifling royalty in certain instances. Where the State (not the Commonwealth) catches the profit-earning concern is by means of a dividend or an income tax. But the Federal Government now invades that area of taxation by legislating that the holders of mining leases must fix a valuation on their property on the basis of what each would realize as a freehold if it formed the subject of a sale between two people thoroughly acquainted with the mine's reserves and potentialities. If an under-valuation is attempted, the Government can take over the mine. It is said that all artificial estimations due to the market price of shares are to be banished from the calculation. Of course it is impossible to do that, for the buyer of a mine in most instances would purchase with an eye to the flotation and sale of an interest through the Stock Exchange. The funny thing, however, is that this is called a tax on unimproved land values. In reality a tax of that class could only cover the outcrop. Shafts, drifts, and cross-cuts are improvements, from the surface down. They are workings for the development of the property. Without them the shoot of ore could only have an outcrop valuation and that might be fractional. Yet, as said, the tax is to be applied on the price the claim would bring as a freehold, and with the knowledge operating all the while of its worth made possible by the improvements undertaken. Certain deductions are permissible, such as surface equipment and shafts, drifts, and levels actually of use for the mining of ore developed. Still in the big mines this deduction is a trifle, and the tax at 9d. in the pound on the market valuation of the claims, as a freehold, will be a heavy impost when added to the State profit or dividend tax. It is believed that the States intend to challenge the right of the Federal Parliament to pass such a tax on their own Crown leases. The judgment given by the High Court that the Commonwealth would collect Customs duties on imports introduced into the country by the State Governments shows the feeling of the Bench in respect to the wide powers of taxation vested by the Commonwealth under the Federal Constitution. Even if there comes a victory for the States on this point, the Federal Government will be faced with a huge deficit. So it can be authoritatively asserted that it will decline to let prosperous mining companies escape taxation any more than it will permit pastoral lessees to get off with only a State income tax.

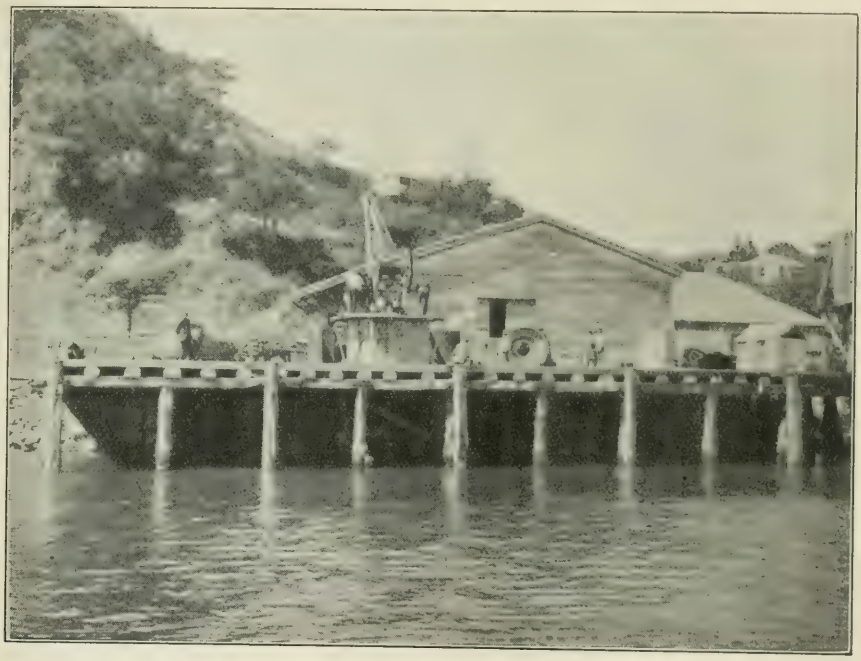
Gold Output.—The full figures of the gold yield of Australia for 1914 are now available. These are convincing as showing the steady decline in our gold output. It was hoped that the opening of copper deposits in North Queensland would help to swell the total, but the decline is so great that much more than that is required to compensate for the fall in the yield. The returns for the past four years are as follows:

	1911	1912	1913	1914
	oz.	oz.	oz.	oz.
Victoria	503,541	480,131	434,932	409,706
N.S. Wales	181,121	165,295	149,657	124,507
Queensland	386,164	347,946	263,343	248,395
W. Australia	1,370,868	1,282,658	1,314,044	1,232,977
S. Australia	11,680	7,340	7,292	7,052
Tasmania	31,101	37,973	35,500	27,320
Total	2,484,475	2,321,343	2,204,768	2,049,057
New Zealand	427,385	310,963	343,407	340,000
	2,911,860	2,632,306	2,548,175	2,389,057

These figures prove the general fall of the gold output of the whole of Australasia. Unfortunately, it is almost certain that this reduction will continue, unless Victoria on the one hand can revive its return by the opening of some of the unprospected deep leads hidden under basalt flows, or unless the vast unexplored desert region of the interior carries some undiscovered mineral region. By going back to 1905, the decline is accentuated all the more. In that year the money value of the Australasian gold output was £17,654,812, or £7,502,927 more than during 1914.

Copper.—The talk is of amalgamations. In North Queensland the proposal is to link the Mount Oxide with the Mount Elliott flotation, the Dobbin & Queensland Freehold Properties. Of course the Mount Oxide is away in the land of Nowhere, but it has resources, though perhaps less than has been assumed by some people, while there is not absolute agree-

ment also over the worth of the Dobbin properties. Still, the amalgamation will be a big market affair. There is also a project for the absorption by the Mount Lyell company of the Primrose, Hercules, and Tasmanian Copper company's properties at Mount Read in Tasmania. The stage of providing a basis of negotiation has been reached by the companies at Mount Read. This is a step in the right direction, for what is needed is that the interests in the district shall be blended and a central treatment works erected. High metallurgical skill will be needed to evolve a method for recovering profitably the metals of the complex ores of the district, but the flotation process has made such advance that it is understood a working scheme has been evolved. If so, an important district will fall into the hands of the Mount Lyell.



THE WHARF AT COOKTOWN, NORTH QUEENSLAND.
Tin-mining is done in the country behind.

The Broken Hill Proprietary Company's iron industry is being well supported by the Federal and State Governments. Orders for steel rails have been received as follows: 2500 tons for New South Wales, 2000 tons for South Australia, 3300 tons for Victoria, and 12,500 tons for the Federal Government. Contracts have been made with American buyers for the despatch of 45,000 tons of zinc concentrate, and further negotiations are in hand.

JOHANNESBURG.

Mining Accidents. — Some time ago much was heard about the desirability of reducing the number of mine accidents on the Rand. With this object the onus of carrying out the Mining Regulations was thrown by the Government on the shoulders of the mine managers. It may seem strange that mine managers on the Rand should not have been expected to take much interest in the working of the Mining Regulations, and that the duty was left to the Mine Inspectors until the last year or so. It is gratifying to find that the alteration has had a beneficial effect. Last year's accidents show a marked reduction as compared with the previous year. For instance, in 1913 there were no less than 3325 separate accidents reported, but in 1914 the number was reduced to 2768. Then again, 89 whites were killed in 1913, while last year the number was 75. The figures with regard to coloured labour show an even greater change for the better, for while 927 were killed in 1913, last year the number of fatal accidents was only 694. Thus we get for 1914 a total of 769 white and coloured employees fatally injured as against a total of 1016 for the previous year. With regard to non-fatal accidents, the total among white and

coloured also shows an improvement. Last year the number was 2387 as compared with 2866 in 1913. There were 337 whites injured as against 360 for the previous year, and only 2050 coloured as against 2506 in 1913. The *South African Mining Journal* has done good service by continually drawing attention to the need for 'safety first,' and to the numerous lessons to be learnt from that movement in North America. The marked decrease in the number of accidents fatal and non-fatal among the coloured employees is highly creditable both to the managers, and to the white miners, because it is on the latter that the safety of the native so much depends. The coloured labourer on the Rand is much lower in intelligence than the native employed in many other goldfields and he is notoriously incapable of taking care of himself. In the past, too little value has been placed on the life of a native, but all this is undergoing a change for the better.

Far East Rand.—Interest continues to be centred on the doings and prospects of the mines in the far east Rand. The mines in the central and west Rand come little into the limelight just now. The passing of the Lancaster West into liquidation has had a bad effect on the western Rand, while the disappointing results at the Crown Mines has also produced a prejudicial effect on the central Rand. With all the capital spent on improving the equipment of the Crown Mines, and the mining talent engaged in its administration, the impression has prevailed that nothing could go wrong, and the result of the searching inquiry now being conducted is anxiously awaited.

With the excellent results obtained at the New Modderfontein and Modder B, coupled with the good returns from the initial crushing at Modder Deep, the star of the far east Rand is again in the ascendant, and for the time being the indifferent results obtained at the Modder Government Areas are excused. The Van Ryn Deep, too, is developing well, Brakpan has rehabilitated itself, Springs has won the confidence of capitalists, and with the excellent results obtained at Daggafontein an opinion is arising that the Government ought to do something at once to turn to profitable account the immense interests it holds in the untouched areas of the far east Rand. It can scarcely be expected that all this area will prove to be profitable, in fact already some of it has been proved to be unworkable under existing conditions. There are, however, some extensive areas that are sufficiently promising to capitalists, providing ample inducement is offered by the Government. From the present condition of affairs in connection with the State Mines, the Government ought to learn a lesson, and in some quarters it is urged that all the risks should not be allowed to be on one side. Several times it has appeared as though the Government was prepared to regard the opening of mines on the far east Rand in a more rational manner, and until that is the case it is to be feared that few capitalists will be prepared to find the immense sums required. A general impression exists that the terms of lease for the Modderfontein Government Areas are much too onerous to be repeated and it is anticipated that more liberal conditions will have to be offered.

Mineral Returns.— The publication of the mineral returns for last year by the Mines Department contains some interesting features. The Witwatersrand mines again crushed a record tonnage, but the value of the yield fell from £35,786,917 to £34,127,918. The gold output of the outside districts was £1,528,896, while from Natal and the Cape Province the gold output was only £7416, making the total value of the gold output of the Union £35,664,230. Coal was raised and sold to the extent of 8,447,923 tons at a value of £2,225,041, while other base minerals were produced to the value of £1,147,659, and silver £102,433, making the total value of the mineral production, excluding diamonds, of the Union £39,139,363. There is a marked decline in the annual value of both the gold and diamond output. Coal also shows a fall in the output, but the price per ton at the pit improved from an average of 5s. 1d. to 5s. 3d. per ton, principally as a result of better prices ruling in Natal. The output of copper shows a change for the better, the improvement being entirely due to the increased output from the Messina mine. Tin is down on the year both in the Transvaal and the Cape Province. Asbestos, magnesite, and lead show a slight increase. The number of whites engaged in the mining industries of the Union fell from 29,512 at the outbreak of war to 25,003 in December, and coloured from 258,903 to 209,040. There was however only an insignificant decline in the number of whites and coloured employed at the gold mines, the serious decline being due to the closing of the diamond mines. The complete figures for last year's diamond production are not available, but for the first half of the year the output was valued at £4,500,000, and we may add £750,000 for the output of the second half,

bringing the value of the year's output to £5,250,000. Thus the value of the total mineral output of the Union was approximately £44,500,000, as compared with £52,925,000 for the previous year, a decline of £8,425,000.

January Output.—The most interesting feature about the January gold output declaration by the Chamber of Mines was the fact that on the Rand there was an increase in value of £88,108. This was mainly due to the appearance of the Modder Deep among the producers for the first time, and to the return to normal conditions of working after the earth tremors at the Village Main and Ferreira Deep mines. Despite the fact that the Crown Mines showed an increase of £4078 in value and Randfontein a decrease of £5930, the Randfontein Central was again at the top of the list of producers by a margin of 1106 oz. over Crown Mines.

TORONTO.

Porcupine.—Since the beginning of March the output has been considerably affected by a shortage of power owing to low water in the Matagami river, on which the two power-plants that supply Porcupine are situated. The Northern Ontario Power Co. cut-off half the supply, except in the case of the Hollinger and the Dome, which have special arrangements. The largely increased requirements of these two companies have added to the difficulties of the situation. Most of the companies have auxiliary steam-plants, which have been put into commission, but this largely increases the cost of operations. No change in conditions is expected for about a month, when the usual spring floods may be anticipated. The property most seriously affected is the Porcupine Crown, which has closed-down half its mill and greatly curtailed underground operations. The Dome statement for February shows an output of $84,412 from the treatment of 21,600 tons of ore of the average grade of $3·90 per ton, as compared with $3·56 in January and $3·53 in December. This slight improvement in grade is not particularly encouraging in view of the fact that throughout 1914 the average grade, with the exception of one month, was well over $4. The North Thompson, operated by the Associated Gold Mines of Western Australia, has been closed-down. The Krist claim, next to the Porcupine Crown, owned by an English company, will be developed this spring.

Cobalt.—Owing to prohibitive insurance rates on ocean shipments, little bullion is now being consigned to London. The companies are either storing their bullion for the present or making shipments to New York. La Rose has reduced its dividend to a 4% annual basis in accordance with its usual conservative policy. This is stated to be pending the com-

pletion of exploration and development work undertaken with a view to adding to the ore reserves, or until more favourable results may be obtained. The Nipissing extracted ore during February of an estimated net value of $164,140, and shipped bullion of an estimated net value of $183,646. The company has abandoned its option on the Teck-Hughes at Kirkland Lake, which occasioned considerable surprise in mining circles. It is stated that an ore-shoot of exceptional promise suddenly pinched out on the 300-ft. level. During 1914 the Timiskaming produced 278,961 oz. of silver of the value of $136,334. Earnings from all sources were $146,649, and expenses $228,071, making an operating loss for the year of $81,422. A vein 4 or 5 in. wide stated to carry 2800-oz. ore, has been found on the 540-ft. level. The Right of Way has a cash balance on hand of $20,862; its gross sales for the year were $66,132, and milling expenses $19,941. Operations have been suspended owing to power shortage, but as soon as a supply is available the mine will be unwatered and an endeavour made to discover more orebodies. The Cobalt Finance Trust, Ltd., a new English syndicate, has purchased three claims in Bucke township, near Haileybury, and is preparing to install a plant and begin active development.

Canadian Mining Institute.—The seventeenth annual convention of the Canadian Mining Institute was held at the King Edward hotel, Toronto, on March 3 to 5, and proved a more successful and important gathering than was expected in view of the war and the financial depression. The attendance was considerably smaller than in recent years, about 10% of the members having gone to the war. In the absence of the president, G. G. S. Lindsey, the chair was taken by A. A. Cole, of Cobalt, vice-president. Addresses of welcome were made by Hon. G. Howard Ferguson, Ontario Minister of Mines, and A. J. Young, of the Toronto branch. An important change was effected in the mode of electing members of council, who have hitherto been chosen for Canada at large, with the result that the central provinces of Ontario and Quebec were unduly represented, while very few members were chosen from the other parts of the Dominion. An amendment, adopted after a protracted and lively debate, provides for the election of councillors by provinces, each province to have a representation in proportion to its membership.

The preliminary report on the mineral production of Canada for 1914 was presented by John McLeish, chief of the Division of Mineral Resources and Statistics. It showed a total production of the value of $128,475,499, as compared with $145,634,812 in 1913, being a decrease of $17,159,313 or 11·8%. The total value of the metallic production was $58,870,028 as against $66,361,351. The production of the more important metals was as follows in quantity and value: Copper, 75,738,386 lb., $10,301,935; gold, 770,374 oz., $15,925,044; pig iron, 783,164 short tons, $10,002,856; lead, 36,337,765 lb., $1,627,568; nickel, 45,517,937 lb., $13,655,381; silver, 27,544,231 oz., $15,097,269; other metallic products, $1,123,919. The fall in the tonnage of pig iron made amounts to 30%. The large decrease in the production of the metals is attributed to the conditions produced by the war, especially as regards copper, nickel, and silver. In non-metallic products the decrease is most pronounced in the case of coal, asbestos, and gypsum, and the products generally classed as structural materials. The total production of coal was 13,594,984 tons valued at $33,433,108, as against 15,012,178 tons valued at $37,334,940 tons in 1913.

In presenting the report of mineral production for the Province of Ontario, Thomas W. Gibson, Deputy Minister of Mines, expressed the view that Cobalt had reached its maximum production, and might be expected to show a gradual diminution in the future. Porcupine, however, showed a satisfactory increase of the gold output. The report gave the total mineral production of the province as $46,632,105, as compared with $53,232,311 in 1913, a decrease of 12·3 per cent.

An interesting discussion on 'The Stimulation of Prospecting' was led by Prof. H. E. T. Haultain, Toronto, during which it was pointed out that if the decline in production was to be arrested it was necessary to discover new mineral deposits. The old prospectors had disappeared, and young men should be trained to take their places. The Government and the mining corporations should organize prospecting. Several speakers were disposed to favour the Australian plan of installing small smelting plants in mining localities, at which prospectors could have their samples tested free of charge. It was finally resolved to refer the question to a committee to formulate a definite policy to be placed before the members of the Institute.

E. T. Corkill, Copper Cliff, Ontario, gave a paper on 'Safety Engineering at the Canadian Copper Company's Works and Mines,' illustrated by moving pictures.

NEW YORK.

The War excites continued interest, with a persistent trend of sentiment favourable to the Allies. Undoubtedly the enormous export of munitions, armament, and supplies to the Allies is checking the irritation arising from interference with trade in other directions. Speaking of munitions, the Bethlehem Steel Company's shares have shown a remarkable rise, owing to Mr. Charles M. Schwab's successful contracts with Great Britain. It is a satire on Christianity to have to associate Bethlehem with howitzers and turrets. Mr. Daniel Guggenheim remarked two days ago that at least a billion dollars—meaning $1,000,000,000—would find its way to the United States this year on account of exports required by those belligerents that are free to do business with this country. The enhanced price of cereals likewise will enrich the farmers and release large amounts of capital for speculative enterprise. Indeed, the general belief that America is on the eve of an enormous industrial expansion is logical. A few significant figures may be quoted. Thus the excess of exports over imports—that is, the balance of trade — for the week ending on March 13 was $47,000,000, which is the largest recorded since such statistics have been kept. On the other hand, immigration from Europe has declined, on average, by 100,000 monthly since the beginning of the war. This will have its effect on the labour market. It was expected that the opening of the Panama Canal would bring an influx of population from southern Europe, especially Italy, but the mobilization of vast armies has prevented anything of the kind. Such a migration, I believe, is only postponed. With the declaration of peace, the impulse to seek a new home on the Pacific coast is likely to be manifested with intensified force.

As regards the diplomatic protest against British interference with over-seas shipments to Germany and its neutral back-doors, it is recognized that most of this protest is in the nature of an effort to prevent the establishment of new precedents. Gossip asserts that Mr. Wilson has German sympathies, but the libel may be ignored, for he is too conscientious to allow personal and professorial prejudice to colour his actions as President. My own opinion is that if the authorities at Whitehall make allowance for the exigencies of politics at Washington, there will be no friction. Differences of opinion may arise, but, *au fond*, this country is in sympathy with the Allies and has no desire for trouble. So far, the diplomatic exchanges have been conducted in the best spirit by both sides.

The Alluvial Flats of the Klondyke.

Mexico. — Conditions continue chaotic. Recent developments indicate no progress toward a settlement. Indeed, I think that matters must become worse before they can be better. Two incidents suggest the way in which the American government may be compelled to interfere actively. The killing of a prominent American, John B. McManus, by the Zapatistas in the city of Mexico, might have led to such action, if Villa had not

hastened to promise inquiry and reparation. Another suggestive episode was the raiding of Dwyer, a border town in New Mexico, that is, within the United States, by Mexican bandits. They dynamited all the safes they could find and commandeered arms and ammunition. A running fight with a sheriff's posse ended in their retreat, after several casualties, across the line. The raid was aimed chiefly to seize ammunition and to start an uprising among the Mexicans living on this side of the border. No serious results are recorded, but something of the kind may lead to bigger reprisals by white people in the Southwest.

On March 13 Carranza imitated the Kaiser by announcing a 'blockade' of Progreso, the chief port of Yucatan; but the prompt despatch, by the American government, of an armoured cruiser ended the farce, the little Mexican gunboat that represented the blockading fleet being recalled by the Constitutionalist leader, now established at Vera Cruz. The American note on the subject was pleasantly peremptory. This attempt to close the port of Progreso was important because it threatened to cut off the export of sisal hemp, of which great quantities are used as binders in harvesting the American grain crop.

It is significant that both Carranza and Villa have been called to order recently by the American government for attempts to levy blackmail on Americans and other foreigners in Mexico. The Mexican Light & Power Co., a British enterprise at Monterey, was asked to contribute $35,000 to the Villa exchequer. The State Department at Washington is protesting vigorously, and successfully, against all special tax levies that are at all confiscatory or arbitrary.

The Zapatistas did not behave well in Mexico city, after Obregon had withdrawn the Carranza forces under his command. Now Gonzales Garza rules in the capital city, he being the Provisional President elected by a convention of generals on January 17, in succession to Eulalio Gutierrez. The latest news is that conditions in the city are much improved and that railway communication both in El Paso and Vera Cruz is about to be restored. The cinema of Mexican misrule is so bewildering that it becomes difficult to retain the names of the generals and presidents seeking to dominate the distressful country. At present five factions are in the field: (1) The Villa-Zapata coalition, controlling the northern territory down to the capital; (2) the Carranza party, dominating the east coast, including Vera Cruz, and much of the west coast; (3) the Gutierrez party, dominant in the states of San Luis Potosi and Nuevo Leon; (4) the bands of Salazar, rampant in Chihuahua and Sonora, near the Mexican Northwestern railway; and (5) mutinous troops in revolt against Carranza in Yucatan. It is a Kilkenny fight and will continue until the weaker factions are destroyed or absorbed by the strongest. The only good feature to record is evidence of a tendency at Washington to act with a little more decision. That may lead eventually to the Cubanizing of Mexico. Assuredly the American people are becoming impatient.

Cripple Creek.—Renewed interest is being taken in Cripple Creek, Colorado, owing to the discovery, in the Cresson mine, at a depth of 1200 ft., of a chamber or vug yielding 200 tons of ore and reported to have been worth $500,000, which has led to an important revival of prospecting. The Cresson is about half a mile northeast of Elkton and at an elevation of 10,000 ft. The company was incorporated in 1895 for $1,000,000, but down to 350 ft. no important orebodies were found. Below 600 ft. the ore-shoots were better defined, and under the active management of Richard Roelofs the property has done well for several years past. In 1913, for example, 51,696 tons worth $800,768 was shipped, the total mining cost being $3·61 per ton, to which was added $4·90 to cover freight and treatment. In 1914 shipments ranged from 3300 to 5300 tons per month, and the value of the ore from $18 to $28. According to H. B. Patton and H. J. Wolf of the Colorado School of Mines, there are two ore-shoots in the mine, lying on opposite boundaries of a cracked and fissured elliptical area in the characteristic breccia of the district and near an intruded mass of latite-phonolite. The fissured area measures 1000 by 500 ft. The northwestern ore-shoot measures 35 by 250 ft. in cross-section and the southeastern 150 by 500 ft. These are essentially two pipes. The chamber in which the rich ore was found was pear-shaped, 23 ft. long, 13½ ft. wide, and 40 ft. high. Around the loose fragments of rock partly filling the chamber, lining the walls, and in fissures extending from it, was a whitish cement consisting largely of celestite, and it was here that the bonanza was encountered. The extension of the ore shoot on the 13th level has now been found. Naturally this find has stimulated prospecting throughout the district and the influx of explorers is considerable.

THE MINING OF ALLUVIAL DEPOSITS. III.

The Installation of Alluvial Machinery for Dredging and Hydraulicking.

By NEWTON B. KNOX AND CHARLES S. HALEY.

Dredging.—Two distinct types of dredge are employed in the principal gold-dredging districts of the world. The machines are so different in design and operation that it may be said that two different schools of dredging exist. The ardour of the champions of each type may be recalled by reference to the discussion that appeared about three years ago in the pages of *The Mining Magazine* concerning the relative merits of the two forms.

What is known as the New Zealand dredge is the older type, and was the first form to successfully attack gold-bearing gravel. It is employed throughout its home-region and in Australia, where conditions are signally favourable for its use. Erected in modified form it has dredged in Russia, Siberia, the Malay Peninsula, Siam, Burma, Africa, British Guiana, the Philippines, Spain, Servia, and Tierra del Fuego. Compared with what is known as the California type, the New Zealand form is a lightly constructed, light-power dredge, usually with a steel pontoon. Its first cost is much lower, and its capacity small.

The above table is derived from manufacturers' estimates. These dredges are built in England, and the price is f.o.b. London. The weight and price include the steel hull. The capacities are doubtless over-estimated, and for actual capacities the yardage quoted should be reduced by from 25 to 50% according to the character of the ground.*

The figures for the last two dredges are for machinery only. The hulls of these were to be of wood. All the above dredges were to be equipped with an open-connected bucket-line and a pan stacker, except the first which has no elevator but discharges from a sluice in the rear.

The New Zealand dredge is specially adapted for a small operating company, whose acreage or capital is limited, and whose gravel is moderately light, uncemented, and easily dug. Its chief application, in our opinion, lies in those districts where lack of transportation is a salient factor and where large, heavy pieces of machinery can only be handled at a prohibitive cost. Here, if the gravel be not too heavy, a well-designed dredge of the New Zealand type should be chosen. Not only will a considerable saving be effected in the first cost, but also in freight charges, cost of erection, and simplicity of repair shops. This saving will offset for some years any higher working cost due to the handling of a smaller yardage than might possibly be dug by the other type.

The California dredge has been evolved from the New Zealand in order to meet local conditions. Several New Zealand dredges were at first introduced in Oroville, and they proved unequal to the task of handling the heavy ground encountered there. As a result, modifications of the type were made, and each newly-built dredge was altered and the method of operation changed until a new type of dredge and method of working were evolved. This type of dredge has been enlarged and strengthened and its power in-

PARTICULARS OF SEVEN DREDGES OF NEW ZEALAND TYPE.

Dredge.	Size of Buckets. cu. ft.	Estimated Capacity. cu. yd.	Digging Depth below Water Line. ft.	Weight including Hull. Tons.	Price f.o.b. London. £	Horse Power
A	3	30,000	20	100	3,000	35
B	4	40,000	20	180	7,000	—
C	5	50,000	26	220	8,000	56
D	6	60,000	40	280	9,100	—
E	7	74,000	32	350	11,500	180
F	3½	—	20	235	4,400	50
G	5	—	20	250	4,625	60

*In Siberia the following yardages are realized by this type during a season of seven months :

4½ ft.	dredge	165,100 cu. yd.
5	,,	190,500 ,,
6	,,	228,000 ,,
7	,,	254,000 ,,

See N. B. Knox, 'Kempe's Engineer's Year-Book.'

creased until it appears to have reached its limit. The evolution of the California dredge can be gathered from the table below.*

The earlier California dredges were equipped with pan or tray stackers, as are all the New Zealand dredges. These have been changed to stackers of the belt-conveyor type. The newer dredges have been equipped with close-connected bucket lines; and these have been found to dig so much greater yardages that the older dredges with open-connected buckets have been altered to close-connected. Finally digging by means of the head-line alone has been found unsatisfactory in California gravels, and all the dredges now employ spuds in digging. The hulls are still chiefly built of wood; but recently some steel hulls have been constructed. For instance, Natoma No. 10, a 15-ft. dredge, has a steel pontoon.

The California dredges vary in size from 3·5 cu. ft. to 16 cu. ft. bucket capacity, and are digging in ground varying in depth from 15 to 65 ft., containing from 8 to 18 cents per cubic yard.

The amount of gravel handled per month and the operating cost per cubic yard vary within wide limits, and depend on the dredge itself, the character of the ground, the size of the gravel, its depth, and the height of the bank.

The scope of the modern California dredge lies in those heavy cemented gravels, to dig which requires ponderous massive machinery, or in those large areas of deep, low-grade gravels lying accessible to cheap transport facilities. Conditions such as these exist at Marysville and Folsom in California and at Ruby, Montana, where dredges of 15 to 16 cu. ft. bucket capacity are operating. In Alaska, small heavily-built dredges of from 1 to 3 cu. ft. bucket capacity and built on Californian lines are working. Some of them are operated by petrol engines.

All dredges built in England have in the past been of the New Zealand type, the manufacturers not being prepared to build machines on California lines. Now Californian dredges of the latest type can be built in England, and, owing to the lower price of steel in this country, can be constructed at a cost of from 20 to 30% cheaper than those built in the United States.

TABLE SHOWING DEVELOPMENT OF THE CALIFORNIA DREDGE.

Date of Comparison.	Size of Bucket. cu. ft.	Horse Power.	Hull Dimensions.	Monthly Yardage.
Mar. 1, 1898	3½	63	80 ft. by 30 ft. by 7 ft.	40,000
Aug. 10, 1911	15	1072	150 ft. by 58½ ft. by 12½ ft.	250,000

TABLE OF CAPACITIES AND COST OF CALIFORNIA DREDGE.

Size of Bucket cu. ft. *Close-connected.	Capacity per month. cu. yds.	Horse Power.	Weight of Dredge without Hull.	Approx. cost of Machinery in New York
		about	Tons	$
3½	50 to 60,000	150	150	40,000
5½	80 to 100,000	250	250	60,000
7½	100 to 125,000	350	350	75,000
10	150 to 175,000	450	450	90,000
13½	200 to 225,000	650	600	130,000
16	250 to 300,000	1000	900	250,000

*Good for 40 ft. digging depth.

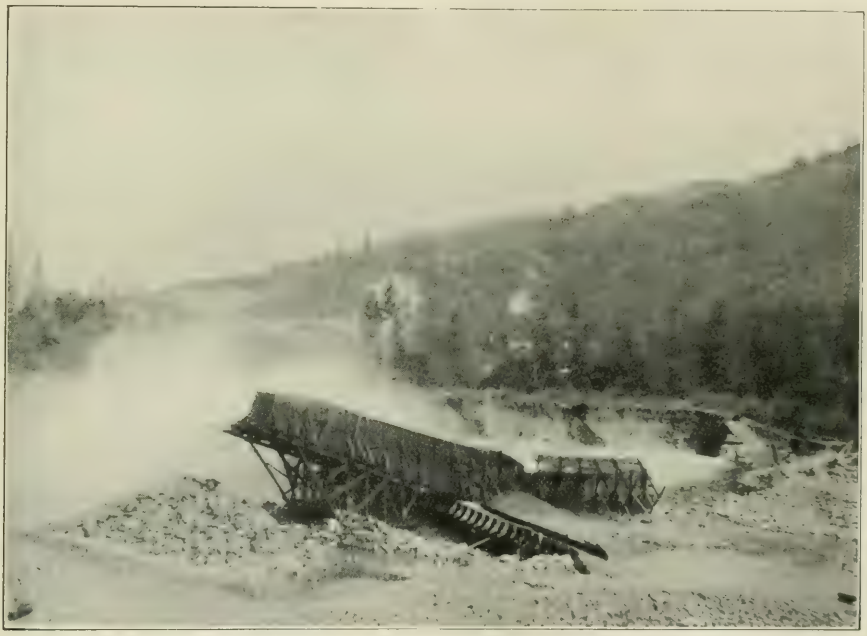
The English steel hull is also better designed and better made than are those of the United States, where steel-hull designing has only recently been started. After bids in the open market, the United States government has purchased its two 54-cu. ft. bucket sea-going dredges in Scotland. These are to be used at the entrances of the Panama Canal and are the largest bucket-dredges in the world.

Australian Pump-Dredge.—This type of so-called 'dredge' is not, strictly speaking, a modification of dredging, but rather of hydraulic mining, employing its water under pressure created by pumping, and raising the gravel by means of a centrifugal pump. It was evolved in Australia, where it has been used with success. Two of this type of dredge were, until recently, working in Cornwall. It has never been introduced into the United

*N. Cleveland. "*Mining and Scientific Press*," Oct. 7, 1911.

States or Alaska, although hydraulic mining using water under artificial pressure has been attempted. The pump-dredge consists of two centrifugal pumps, one known as the pressure or nozzle pump and the other the gravel pump, mounted, together with motive power, upon a wooden hull or pontoon. While working, the pontoon rests on bed logs laid upon bed-rock, and it is only floated when moved nearer the working face. The mining is done by directing a small hydraulic nozzle against the bank. The artificial pressure employed is usually 60 to 70 lb. per sq. in. produced by a centrifugal pump of 12 to 14 in. discharge. From the bank the gravel is sluiced through runs cut in bedrock to the sump, which should never be deeper than 20 ft., the limit of the suction. When the bedrock is wavy and dips away from the sump, considerable expense is involved in cutting down the runs to grade; indeed when the bedrock dips too steeply away from the sump, it sometimes will not pay to move portions of the overlying gravel, which are then left behind. As the gravel is piped, all large boulders are forked-out and left behind on bedrock.

The gravel from the sump is raised by the gravel-pump to the line of sluices, a height depending, of course, upon the depth of the deposit and the fall of the sluice-boxes. A height of over 60 ft. requires the installation of a second lift-pump. The gravel-pump is usually placed side by side with the pressure-pump on the barge, but in shallow ground this pump can be worked from the bank, and it is then placed on bedrock. The gravel-pump is from 8 to 12 in. discharge. A direct-acting or small centrifugal pump is installed at the head of the sluices to furnish them with wash-water. From the ends of the boxes, the tailing flows back into the worked-out paddock, and is there retained by brush-wood dams. In countries having an anti-debris law, this impounding of tailing is a point in favour of this type of mining.



Elevator-Giant driving into Ruble Grizzly.

The total power required depends on the size and capacity of the plant and the height of the lift. It varies from 120 to 260 h.p. The capacity varies accordingly, and ranges from 6200 to 12,300 cu. yd. per week, the average being about 7500 cu. yd. These figures are taken from the Government Report of Victoria. The total operating cost varies from 4·5 to 6d. per cu. yd. The time lost in shifting plant, flooding paddock, building dams, and all repairs is a serious item. In some cases it amounts to 10 weeks in a season's run of six months. During moving, more men are required than are employed in ordinary running. In the cases quoted, the

crews are stated to be from 11 to 50 men per dredge.

While this method of mining has its own application, it is nevertheless contrary to all economical principles of engineering. Its efficiency is only 30 to 45%, and the amount of water lifted per cubic yard of solid is enormous, 95% of all material lifted being water. This moving of useless material affects the cost, which is apparent in the figures for the work done during 1907 in Victoria. Over ten million cubic yards was treated by bucket-dredges, and nearly the same amount by pump-dredges. The cost per cu. yd. in the former case was under 3d., whereas in the latter it was over 10d. As, however, the pump-dredge treated all the tough, irregular, and deeper ground, which the bucket-dredge could not handle, the above comparison of costs is unfair to the pump-dredge. Conditions being equal, however, the cost of pump-dredging would be about 2 to 2½ times greater than bucket-dredging.*

PUMP-DREDGES IN VICTORIA.

Year	No. of plants	Time in weeks	Cu. yd. treated	Tenor per cu. yd. in pence	Area worked in acres	Amount of gold per acre in oz.	Men employed	Cost of plants £	Average working cost per plant per week £
1906	49	1471½	6,432,008	6·63	192	218·16	1576	—	—
1907	84	2092½	9,670,362	4·62	301	183·7	1876	—	96
1908	71	1534⅛	7,525,903	6·375	239⅓	199	1747	230,300	—
1909	52	965	4,645,962	7	141½	225·7	1120	176,374	90
1911	36	*870	2,952,721	4·75	92·7	183·6	568	95,451	—
1912	26	386½	2,445,000	4·67	69·8	159·7	407	65,000	86

*605 working weeks, 265 weeks repairing and shifting.

The above table, covering the work done by "pump hydraulic sluice dredges" in Victoria from 1906 to 1912, has been prepared from data in the Annual Report of the Secretary of Mines. It is unfortunate that the operating cost per cubic yard of material treated has not been given.

Hydraulic Methods.—Assuming that the results of a careful examination of the deposit have indicated the hydraulic method as the most feasible of operation, we will discuss the salient points of installation. The first question to arise is that of getting the needful supply of water under working pressure. In hydraulicking, this is usually the most costly feature. A ditch and flume several miles in length may have to be dug and constructed. A timber or stone and concrete dam may have to be placed in the river or stream at the point of diversion of the water. Or a tunnel may have to be cut through the solid rock for several hundred feet in order to avoid the washing-out of the flume by annual floods, characteristic of torrential streams.

The more intimate details of this work, as of other parts of the installation, are hardly within the scope of a short article; but the broad general principles of procedure will be briefly described.

As a continual supply of timber for building and removal of flume, for construction and extension of sluices, for building houses, and for innumerable other purposes, is an almost daily necessity at all hydraulic properties of any size, the first detail is that of the saw-mill. If possible, this is usually located near the head of the ditch, either above or below the point of diversion of the water. As fast as the ditch and flume are built, water can thus be used to carry timber to the point where it is needed, and, later, to the mine itself. In heavily-timbered countries, this is easily possible. Advantage is usually taken of some small gully running back toward the thickest timber to build a skidway; and as fast as the logs are sawn to regulation lengths, they are shot down the skidway into a pond, or against an embankment, immediately above the mill. If the mill is at or near the ditch-line, where the latter has already gained enough distance above the river, the ditch will supply power for running the saw-mill.

A suitable supply of timber, thus being assured for flume-building purposes, great pains must be taken, and a good deal of judgment used, in digging the ditch. Not to enter into too much detail, we may say that the grade should be suitable for the quality of the soil, the front bank wide and firm, and the hill bank

*See H. Herman in *Australian Mining Standard*, October, 1908.

well sloped. The main idea of its design is to keep the force of the water, as well as the greater portion of the friction, back against the hill as much as possible; yet not so much as to cause extensive under-cutting and slides. To avoid these latter nightmares of the hydraulic miner, even when the ditch has been well constructed, one or more ditch tenders are necessary. There are, of course, innumerable methods of ditch repairing and bracing known to the experienced miner.

Turnouts and sand-gates at frequent intervals are essential, and in case of breaks in the soft ground. It will eventually have to be flumed, which, when the footing has slid away, will be done at a much greater cost.

Above all, it should be borne in mind, while constructing a ditch and at all other times, that when the giants are not working there is no money going into the sluices; and nothing is more costly than shutting-off water to repair ditch breaks during the mining season.

Having brought the water above the property with the desired head, the next thing requiring careful work is to get it down to the working face. If the pressure is great and

RUBLE ELEVATOR AT GILTA, CALIFORNIA.
Note the sluice under the inclined grizzly.

ditch may save much damage. Changes of grade should be avoided, unless there is a marked change in the character of the ground, as the point of change merely fills to the regular grade with cuttings brought down by the water. If the grade used for the roughest surface be carried throughout the ditch, things are on the safe side. The flume grade will of course be constant, and much less than the ditch grade. Care should be used in blasting through hard rock, to prevent excessive fracture and consequent leakage. The whole ditch should be carefully puddled with clay or sawdust at frequent intervals.

Ground that is apt to slide should be flumed in spite of the temptation to dig the ditch in the hill-side steep, the greatest care must be taken in bracing the lower portion of the pipe-line. The details of line, gate, and elbow-bracing, as well as of penstock building are matters of practical experience, and if intimately described would fill a small volume in themselves.

When everything is ready to start laying the branch strings of pipe and setting the giants, the question of the proper method of working the ground arises. This calls for the exercise of good judgment. Ground that has only an ordinary dump into a river that depends upon annual floods to carry away excess tailing, should never be opened from the lower end, as a dam will be formed, and all

detritus from the workings, including the fines, will fill up the river and spoil what dump there is. On the other hand, in case of good dumping facilities, it is well to open at the lower end and take advantage of the bedrock slope in laying sluices. If two strings of sluices can be so laid that one giant can be set between and turned from one to the other, while heavy boulders are being blasted or removed by derrick, efficiency is gained. In case a dump giant has to be used to pipe dump up river (it should never be piped down), the water may be turned into it at similar odd times. The use and placing of a derrick, equipped with chains, for the larger boulders, and stone-boats for the smaller ones, requires judgment and experience. Care must always be taken not to cause blocks with boulder piles.

There are two general types of California practice in hydraulic mining methods, brought about by different sets of conditions. In the eastern portion of the state, tributary to the Sacramento river, and now practically closed by the debris law, the gravel banks are for the most part deep and have excellent dump. As a result, when bedrock cuts were started for sluice-ways, their depth was usually so calculated that when a string of sluices reached the limit of the workable ground, it would still be in bedrock. Thus the sluices were always kept up to the face, and all giants were employed in cutting-down the bank alone. This tended toward greater duty and efficiency, and the man who so miscalculated his cut that he had to use a 'booster giant' to drive the gravel across bedrock to the head of his boxes was regarded as a poor miner.

On the other hand, in Northern California, on the Trinity and Klamath and their tributaries, where many of the richer bars were low-lying, the ' booster giant ' became imperative and a matter of general practice. Cutting is done by the field giant, which is, of course, kept close to bedrock. Driving across bedrock to the head of the boxes is done by the booster, which is often placed on the bank in line with the boxes. By the shallow cut thus necessary for the sluice-way, many feet of dump are saved.

Speed and efficiency in handling ground are largely dependent on the personal factors of judgment and experience. Gold-saving, on the other hand, is more a matter of common-sense. On this point so much has been written and the inclination is to go into so much more detail than is permissible in a paper of this scope, that we shall confine ourselves to general principles.

For the saving of fine gold, it is generally conceded that railway iron (usually about 40 lb. weight per yard) laid across the boxes, and spaced at 2 to 2½ in. apart, or Hungarian riffles (2 by 4 in. scantlings covered with steel straps) are the best form of riffles both for security and durability. In some places it is not always possible to secure the necessary material, however, and sluice-blocks sawn from fir trees, about 10 in. thick, are often used instead.

In the case of fine gold, one or more undercurrents should always be used no matter how long the string of sluices. Quicksilver is usually left out of the first few head-boxes, but in the lower boxes should be used carefully, too much being nearly as harmful as too little. Care of course must always be used in planing and caulking sluice-bottoms to avoid loss. Flooding of sluices by the pipes, with its constant fluctuation, should never be allowed. To avoid this where possible, some lead water should be employed independent of the giant water. The grade of sluices depends upon local conditions, varying generally from 3 to 9 in. per 12-ft. box; 6 and 7 in. are good grades with which to operate. Details of sluice-building and bedrock cutting can be found in any of numerous reference books.

In concluding the general subject of hydraulic mining, it may be wise to mention again the subject of artificial heads, discussed already under physical factors. This has been repeatedly attempted in Alaska, and, in all cases of which we have knowledge, has resulted in financial failure, probably in a measure due to the high cost of power. A case where an installation of this sort seemed justified, however, was one erected some years ago in Siskiyou County, California. Here the property was so located that water could not be brought in under natural head. Dumping facilities were good. There existed, a mile away, ample cheap water under pressure, which was converted into electric power and transmitted to the mine. There motor-driven pumps were utilized to create an artificial head for the giants, pumping from the river below. The ordinary hydraulic method was applied.

Hydraulic Elevation.—Under the head of physical factors we have already mentioned the chief disadvantage of these machines, low efficiency. However, there are many deposits in California and elsewhere which have been successfully worked by this means, thanks to the presence of abundant cheap water.

The usual means of operation is to blast

out a pit or sump, about 4 ft. deep and 10 or 15 ft. square, in the bedrock. The receiving end of the elevator is set in the lowest portion of this pit. The sump should be centrally placed, as a great deal of time is required to move the elevator, with consequent loss of water-season. Except where the gravel is very fine, a derrick and stone-boat are used in connection. A grizzly is placed in front of the intake, whose bars are spaced at least one inch closer together than the width of the elevator-throat. At frequent intervals the grizzly must be cleared by hand labour, assisted by the stone-boat. As a result, during the formation of a vacuum in the discharge column. It is certainly true that this machine will give a greater lift for a smaller head than other types. It may be added here that our experience with hydraulic elevators has, on the whole, been rather disappointing.

One of the most successful elevators that has come under our notice was constructed on the mine, at the property of the North Fork Salmon River Mining Company in California. It consisted of a steel-lined box about 18 in. square inclined at an angle of about 50°, with a 5-in. jet at the bottom and a half-inch steel striking-plate at the top, imme-

'Boiling-out' with Ruble Elevator.

these intervals there is a loss or waste of power, which varies with the amount of boulders in the ground. It has been stated by manufacturers of these machines, with evident pride, that the greatest difficulty of the miner is in getting enough gravel to the elevator to keep it working at capacity. The chief reason for this is that so much power is required by the elevator that there is usually not enough water left for the giants to cut-down and drive the gravel properly.

The fact remains that the efficiency of these machines is low. Of the principal types now on the market, in our opinion, the Evans elevator is perhaps the most efficient, due to the air-suctions used on either side, which prevent

diately over the sluice. The material was elevated about 30 ft. The operating head was about 250 ft. The water-supply was exceptionally good and about 700-in. was required for the elevator. Boulders up to 11 or 12 in. diameter were handled, and there was no attempt at constructing a throat, everything being lifted directly on the jet. The capacity was approximately 1000 yards per day.

Ruble or Grizzly Elevator. — As before stated, this form of elevator is simple and is usually constructed on the ground where it is to be operated. It consists of an inclined chute (see illustrations on pages 213 and 215), at an angle of about 17° and about 100 ft. in length, including a 10-ft. apron, which is used

to make connection with bedrock. This apron is set with its walls fitting closely inside the walls of the main elevator-chute, which is about 90 ft. long. When moving, the apron is moved separately.

The chute itself, as well as the apron, is lined with $\frac{1}{4}$ in. steel sides and $\frac{3}{8}$ in. plates on the bottom. It is about 8 ft. in width, and the walls taper from 12 ft. in height at the bottom to about 4 ft. at the top. For the first 20 ft. of the incline the bottom is solid. The remaining 70 ft. consists of grizzly-bars spaced about $2\frac{1}{2}$ in. apart, running transversely; these bars are made of 2 by 6 in. timbers covered with straps of $\frac{1}{2}$ in. steel. Underneath the grizzly is a false bottom which slopes down from the upper end of the elevator to the sluice-box, which in turn runs out at right angles from under the main chute, directly under the lower end of the grizzly. Both the false bottom and the box are lined with light steel, and 6-ft. extensions are built from the latter on separate bents, set at the desired grade, until about 60 ft. of sluice is obtained. The riffles used are Hungarian, 2 by 4 in. timbers covered with strap steel, set at intervals lengthwise, but mainly crosswise, of the sluice. If desired, the sluice can be covered and put under lock and key.

The supporting structure of the main elevator is built on three long stringers about 12 by 14 in. in size. Bents 4 by 6 in. are built crosswise upon them to support the chute. Iron rods may be used for bracing. The whole grizzly is mounted upon skids set crossways of the stringers and supported by blocks resting upon bedrock. When moving, a roadway of these skids has to be built ahead of it. Moving is done with a light winch and a cable, one mule furnishing ample power.

The method of operation is as follows: The elevator giant is set squarely in front and in line with the middle of the grizzly, about 80 ft. back from the bottom. Wings are built out on either side of the elevator, one wing reaching clear to the bank. The wings are about 10 ft. high, and faced with the poorest timber scrap on the place as a protection. The supporting frames can be made so as to be portable and quickly set up by bolts. They must be well braced from behind, as gravel is constantly being slammed against them by the giant.

The field or cutting giant starts operations behind the elevator giant and works along the face from bedrock, taking a layer from 10 to 20 ft. thick, driving it up along the bank to the wing of the elevator, and piling it. From this point onward it is taken in charge by the elevator piper. As both giants are often in operation at the same time, a rough shed is built over the elevator giant to protect the piper.

The piper must use great care in order to avoid loss of fine gold. He picks up a few cubic yards of material and drives it up the solid portion of the incline. Then he carefully 'boils-out' the fines over the lower portion of the grizzly (see illustration on page 217). The fines go through into the box, and not until the boulders and heavier stones are clean and bare are they pushed over the end of the machine. A few are always left on the grizzly to act as a baffle for flying fines and gold, as the latter has a tendency to flick over the end on the giant spray. After the fine material has thus been separated and put through the grizzly and the boulders driven over the end, the action is repeated.

About every hour or so the giant must be swung to one side, and the fine tailing that is collected and heaped at the discharge end of the sluice piped away. A dump giant is kept at one side to pile-up at odd moments when the water may not be in use in either of the other two.

When the field giant has been advanced along the face until it has cut its entire swathe, it is drawn back again and another layer of 10 or 20 ft. removed. From one setting of the machine a tremendous amount of material can be reached, especially if the pressure is good.

When the boulder dump is filled to the top of the machine, sills are laid on it with a platform of boards as an extension of the elevator. This operation is repeated every two or three days till the dump is piled much higher than the machine. Then the dump giant is run forward, the whole pile piped down in a few hours, and a new start is made. (See illustration on page 219).

When the driving limit of the field giant has been reached, the machine must be moved. The time required to do this (5 or 6 days) is one of its chief drawbacks. This can only be obviated by using two or three machines and changing the water from one to another. In this way, two machines can always be kept in operation while one is being moved. With a 50-ft. bank, and the field giant working under 400 ft. of pressure, the elevator should be good for at least four weeks work in one place.

As previously stated, the machine is moved by winch and cable. Great care must therefore be taken to have the skids level and firm, so as not to rack it.

One of us has operated a machine of this type on ground carrying about 5d. per cubic yard, with about 8 ft. of dump into a small river. From 600 to 1200 in. of water under about 450 ft. head was available for about four months of the year. During this time 100,000 yards of gravel was handled, and the total operating expenses, including ditch maintenance and all preparatory work, was £1200, or 3d. a yard. As the gravel was heavy, containing nests of boulders from 1 to 5 tons in weight near bedrock, and the bank was only 20 to 25 ft. in height, this may be considered a fairly low working cost. The powder bill for the season, with powder at a shilling a pound, was about £40, because all rocks that would not conveniently go over the grizzly had to be blasted to about half-ton size, or a trifle less. Boulders weighing more than a ton could be put over the machine; although of course very slowly, so that it was not good practice to do it.

Although the mine was distant 90 miles from the railway and all steel had to be imported, the total cost of the machine erected upon the ground was about £700. The capacity was from 1000 to 2000 yards per day of 24 hours. It is our opinion that this capacity could be increased at least 50 and perhaps 100% by the use of an automatic gate at the upper end of the machine, which would keep all fine gold from flying over, and obviate the necessity of losing time in careful boiling-out of the fines. This would also prevent any loss due to careless piping, as the material could be jammed through the machine almost as fast as the pipe could carry it without danger of gold flying over.

Conclusion.—It has been our aim, in the course of these papers, to discuss the salient points of the adaptation and application of the more common types of alluvial mining machinery, both from the standpoint of the examining as well as that of the operating engineer. For reasons stated in our introduction, we have not gone fully into the question of dredge operations, as we felt that we could contribute nothing original to a literature already replete.

PHOTOGRAPH SHOWING THE SIZE OF BOULDERS PUT THROUGH THE RUBLE ELEVATOR.

Of all classes of mining, however, herein discussed, it is our opinion that dredging promises to be the least speculative. Indeed, we know of no other class of mining where the element of risk is so minimized as in that of an intelligently proved dredgable deposit. The amount of gold, or tin, can be fairly accurately determined and from the data of operation of dredging under similar conditions, costs and yardages can be closely, if not exactly, predicted. Consequently its present and real value can be estimated with confidence.

COPPER MINING IN MICHIGAN

A discussion of the present problems at the Lake Superior copper mines.

By THOMAS T. READ.

THE petrographic province of the Keweenaw series of Michigan, locally known with pride as 'the copper country,' is one of the most famous mining districts of the world. The Keweenaw peninsula, on the southern shore of Lake Michigan, consists geologically of a series of volcanic flows with interbedded sediments, having a total thickness of about 27,000 ft., overlain and underlain by sandstone. The flows dip to the northwest at an angle of from 30° to 70° and strike at about N 40° E. For a distance of over 100 miles from northeast to southwest these flows are characterized by the presence of metallic copper, occurring in such abundance as to give rise to many deposits of workable grade and some of great richness; in fact, one fourth of the profits made from copper mining in the United States have been derived from these deposits, corresponding to a total of over $200,000,000 in dividends. These profits were made from the production of a total of nearly 2,700,000 tons of copper, and until about 35 years ago this district was the only important copper-producing region in North America. The production during 1912 of 216,609,000 lb. was only 15% of the total production of the United States, and yet it was nearly ten times the output of forty years previously. So much has been written about this district that it seems almost unkind to add to the burden of literature. Yet in the course of the past decade what may be called an economic revolution has been brewing in the district, with the result that highly significant changes in practice have been brought about. What these are, the reasons for their being, and the influence they are likely to have on future work, seem to be worthy of record.

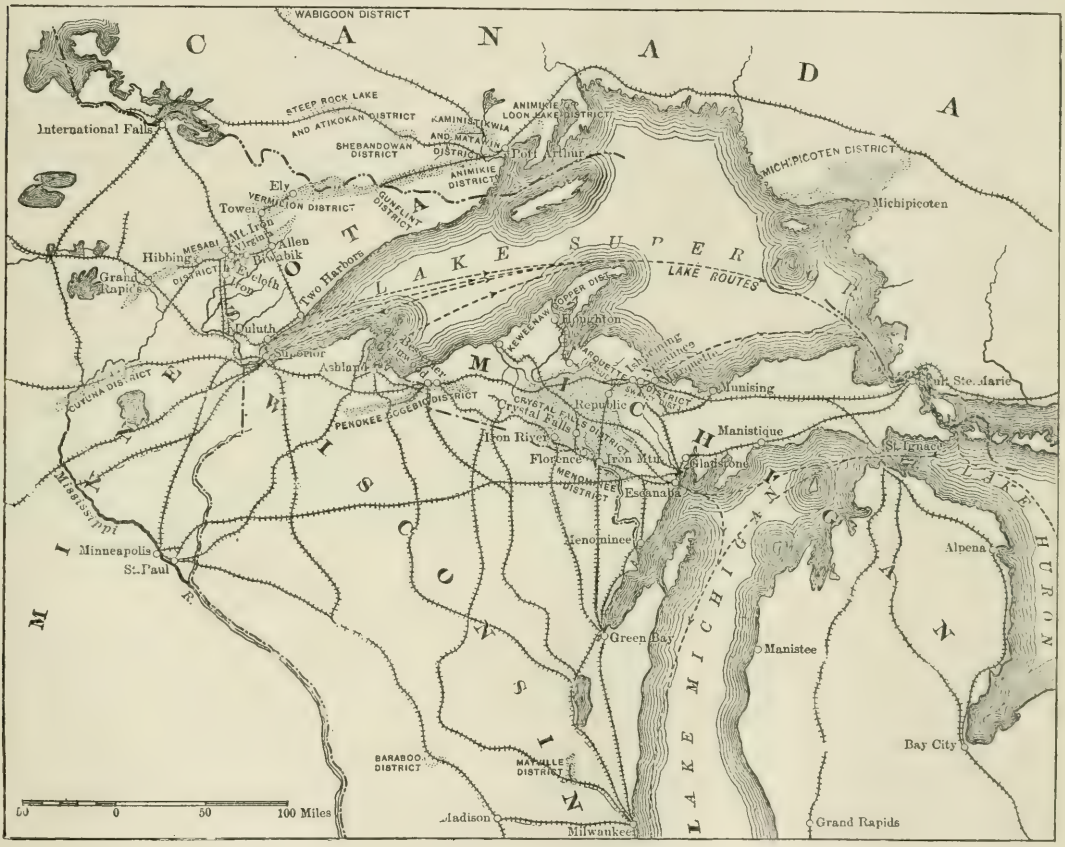
A man is as much the product of his heredity as of his own efforts, and the same is true of every human institution. The present mining methods of the Lake Superior district are partly an adjustment to present conditions and partly an inheritance from the methods of the past. To understand them clearly it is necessary therefore to recall briefly the history of the district.

The copper occurs in the beds in sizes from particles of microscopic size, up to great masses, one weighing 430 tons having been found. Masses of considerable size were quite common along the outcrop of the lodes and were utilized by the aborigines in their primitive metallurgy. Deposits so conspicuous as these could not escape notice by the early explorers, and they are mentioned in books of travel as early as 1636. Over two centuries supervened before real mining operations began. In 1843 the title to this area, until then belonging to the Chippewa Indians, passed to the Federal government and an era of rapid development and wild speculation began. The Cliff mine produced $1,328,400 worth of copper in the seven years between 1846 and 1853. Other mines were being developed; some of them did almost equally well, but there was also the wild and baseless speculation so familiar to the history of mining districts. At first copper was extracted from veins, now recognized as exceptional rather than characteristic of the district, and many years passed before it was recognized that the largest amounts of copper were to be obtained from the volcanic flows throughout which it was disseminated. For a time attention was directed chiefly toward the mining of the large masses of copper, and it was only with experience that it became clear that greater profits were to be made from the lodes in which the proportion of copper was small, but the tonnage great. Thus the trend of progress has departed from the laborious extraction of masses of pure copper toward the cheap mining and reduction of enormous tonnages of ore, from each ton of which a few pounds of disseminated copper may be recovered. The influence of heredity is inexpugnable, however, and the masses of copper still to be found determine inevitably the general lines of procedure, as we shall see.

The first skilled miners to invade this district were Cornishmen, whose methods and ideals have had a strong influence on practice. The copper is not distributed uniformly through the lodes, except in rare instances. Exploration therefore was extended downward and sideways from the point where copper

was found. The use of inclined shafts, in the vein itself, and the starting of stopes next to the shaft, advancing outward, was an inevitable outcome of these conditions. But the eventual result was much like the Chinese language; the simplest possible method of meeting simple requirements, when adapted to meet complex necessities, in the wake of industrial evolution, was bound to prove cumbersome. The present huge mines of the region are nearly all laid out and operated like small mines, and at no small disadvantage. In the workings on the conglomerate lode of the Calumet & Hecla no less than 300 men are kept steadily at work remedying the difficulties that result directly from the placing of the working-shafts in the lode itself. In all the mines a great extent of workings has to be kept open for long periods, until the last of the ore at the far extremities can be taken out, creating a source of expense even though it does not appear as such in the cost-sheets.

It is not my purpose here to go into details of Lake Superior methods, these having been described admirably by T. A. Rickard in his book 'The Copper Mines of Lake Superior.' I must proceed, therefore, without further discussion of this aspect, merely pointing out that if it could have been known in the beginning that the principal mines would develop to their present size, the working-plans would have been laid out to better advantage. It was not possible for this to be known, however. The engineer accustomed to determine, by drilling, the limits of his orebody and its exact metal-content, thus placing his working-shafts in the most advantageous position and planning all his work with regard to the known shape and structure of the orebody, will be inclined to suppose that a similar method of procedure should be adopted in developing one of these mines. But this is not and, in most cases, cannot be done. The irregular copper content of the lodes has already been mentioned, and the difficulties of sampling such



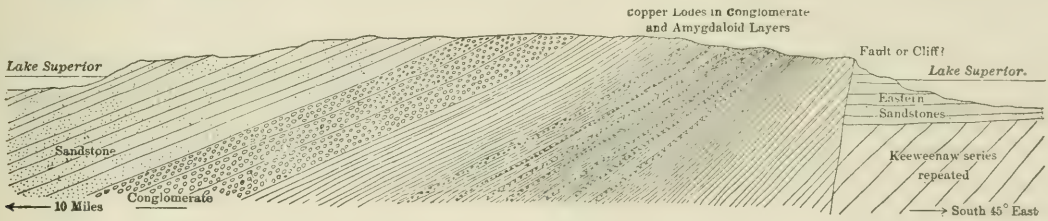
MAP SHOWING THE POSITION OF THE LAKE SUPERIOR COPPER REGION.
(From Van Hise and Leith's 'Geology of the Lake Superior Copper Region.')

an orebody have been suggested. They are so great that systematic sampling is,in general, not attempted, the appraisal of the copper content of a drift or stope-face being left to the skilled eye of the mine-captain. This system has obvious advantages, of which the one undeniable is that by it numerous profitable mines have been developed. The Arcadian, on the other hand, on which sampling and testing were carried to a greater length than on any other property, eventually proved of unprofitable grade after some $2,000,000 had been spent. Another point that cannot be over-emphasized is that ore changes from profitable to unprofitable grade, or the reverse, almost over-night. In the past thirty years Lake copper has ranged from a price of 9 cents per pound up to 21 cents per pound. At the lower price much of the partly developed ore in the mines would represent only an object of unprofitable expenditure; at the higher figure the blocks of ore left in the old workings are too low-grade to become a source of excellent profit. There is thus a double uncertainty; it is impracticable to determine the grade of ore in the lower workings; it may or may not be of workable grade, and if of a grade now workable the price of copper may have so declined by the time the stopes are ready to yield ore that it is not of workable grade after all. The practice of not developing ore far in advance, and the keeping of a large extent of workings open, so that access at any time may be had to low-grade ore, left behind as unprofitable in earlier work, is therefore an evidence of good management. When these and other factors, into which the limits of space prevent my going in detail, are once thoroughly understood, it is seen that the impression prevailing in some quarters that the mining methods of the district are somewhat inept has no basis in fact.

The point made in the preceding paragraph must not be allowed to obscure the fact that the changed and changing conditions have made certain modifications of method necessary already,and increasingly necessary. The chief factor is the continually rising cost of labour, combined with a decreasing margin of operating profit, or, in other words, a lower net return on capital. Future work must be planned and present methods re-adjusted in order to conform to these conditions. A notable step has been taken by the substitution of the 'one-man' or 150-lb. drill for the heavy air-drills formerly in use. These light drills not only do as much drilling with one man to attend them as the larger drills did with two, but have proved economical in a variety of unexpected ways and have greatly decreased the cost of mining. A similar economy needs to be effected in loading the cars with ore and tramming them to the shafts. This is now done by hand, at an excessive cost. As is well known, no successful device, other than a properly operated mechanical shovel, has yet been devised for loading ore into a car. In these mines the slope of the deposit is such that in most of them the broken ore can be loaded into the cars underground directly through chutes. In some of the mines the foot-wall is in places too flat for the ore to roll down unassisted, and in all of them the loaded cars must be guided to the shaft, dumped into the skip, and the empty cars pushed back by hand. Mechanical haulage has not been introduced for the adequate reason that by present methods of work the amount of ore being hauled daily on a single level is not sufficient to pay the overhead cost of a mechanical system, while the workings themselves are in many cases too irregular to permit the easy introduction of mechanical haulage. In one mine the necessary readjustments have been made and electric haulage is in use; in another the shafts have been placed farther apart than usual and mules are employed to haul supplies, much like coal-mining practice; but in most the use of hand-tramming is standard practice. The substitution of some other means for this hand-labour is not only a necessity from the standpoint of cost, as indicated, but also because it has at times been difficult to secure enough men for this work to maintain the desired output.

Except in the case of the Calumet & Hecla conglomerate lode, the cost of timber has never been an important factor. The hanging walls of nearly all the lodes are so strong that they will stand almost unsupported for long periods of time and over large areas. But the net result is that at last the roof comes down. Frequently so large an area is involved in the eventual collapse that the damage to the mine workings is serious. It was the under-estimation of this factor that caused the loss of the Atlantic mine, which was long a model of efficiency. In the case of the Calumet & Hecla conglomerate, where the hanging wall is heavy, the workings have been supported by the use of timber. In none of the other mines is the ore rich enough to bear the cost of timber supports, and it is fortunate that they are not needed. In the Copper Range properties the workings are filled with such waste as can be sorted out underground, this

being supplemented with the sand residue from the stamp-mills, which is brought back in the ore-cars and introduced underground through a hole and a series of winzes adjoining the shaft, being distributed underground through pipes by the aid of compressed air. This system has been in use too short a time to determine whether the results are satisfactory and the cost permissibly low. At other properties the problem is being studied and no doubt some satisfactory solution will be reached. It may be asked why a caving system is not adopted. There are various good reasons against this. In the first place, a caving system presupposes ground that will cave easily, and it has already been pointed out that the hanging wall is strong. Another difficulty is that most of the lodes dip at an angle of only about 45°; material caved upon the foot-wall would not follow down, and it would be necessary to cave a continually increasing thickness of overburden. Many of the numerous towns



Geological Cross-section across the Keweenaw Peninsula.
(From T. A. Rickard's 'Copper Mines of Lake Superior.')

and villages of the region are situated above the lodes, and the use of caving methods in such places would lead to innumerable difficulties. Also the caving of the overburden would turn the mines into sumps for all the drainage of the neighbourhood and introduce a pumping problem from which the mines are happily now free, as the amount of water to be handled in the present workings is in most cases negligible.

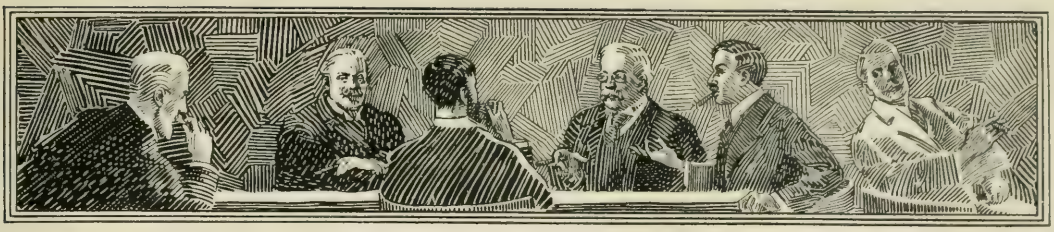
To summarize then, the future of the Lake Superior mining district appears to involve the working of deposits of gradually decreasing grade with labour of which the cost is continually increasing. Three lines of attack are open: the readjustment of methods so as to decrease the need for labour, to design and conduct operations so that the working costs may be a minimum, and to perfect methods so that the copper may be more completely recovered from the ore mined. The readjustment necessary has already been briefly considered, and the second line of attack must be still more briefly treated, as it has been in part covered in the foregoing. Generally speaking, it will be necessary hereafter to proceed with more boldness, abandoning the caution that characterized the older work. More money will have to be spent in exploratory work and more money risked. In short, the mining of the future will tend to be more like ordinary industrial business and less like ordinary mining. In ordinary mining there is uncertainty as to the governing physical conditions; the size, richness, and persistence of the orebodies, for example. In industry the physical conditions are generally known, the uncertainty lies in the business conditions; the cost and effectiveness of labour, the marketability of the product, and so on. Once physical conditions are known, considerable differences in the design of the enterprise become possible. Shafts may be placed in the most advantageous position, the workings may be laid out so that the work can be performed at a minimum cost. Work can be concentrated and planned so far in advance that mechanical means can be provided and, in general, overhead costs can be cut down by arranging to perform a maximum of work with a minimum of equipment. All this ambitious programme seems to me to be contingent on finding a means of determining in advance the size and value of the ore deposit to be exploited and, as already indicated, I am by no means sure that any completely adequate method is yet available. Exploration by the diamond-drill is the most satisfactory method in use. Its chief drawback is obvious; the ore brought up by the drill cannot be regarded as a reliable index of the average copper content of the lode. Unfortunately there does not seem to be any way in which an absolutely reliable sample can be secured, yet the development of diamond-drilling seems to be the most promising line of campaign.

Notable progress has already been made in securing increased recovery from the ore after it is mined. The nature of the ore so clearly indicates the general character of the treatment

methods to be used that not much discussion of the leading principles is possible. It must never be forgotten that the ore consists of a soft and ductile metal distributed through brittle rock in fragments varying from microscopic size up to huge masses too heavy to move. The earliest workers contented themselves with the recovery of these masses. Later work has been directed toward securing more and more of the fine copper, in order to approach a 100% recovery of the metal in the material handled. The larger masses are separated by hand in the coarse-crushing plants, of which there is one at each shaft, and of which the design and operation have been so perfected as to make working costs remarkably low. As a result no mass of copper larger than 4 to 6 inches in diameter reaches the concentrating plant. Here the ore is crushed at one operation down to 3/16 or 5/8 inch; in the latter case it is screened through a 3/16-in. screen, the over-size jigged to free it from copper, and the jig-tailing returned to the primary crusher. This remarkable performance is done in a steam-stamp that is able to deliver a sufficiently heavy blow to crush efficiently a huge tonnage of such coarse ore in a single mortar. It is evident that the mortar would speedily become filled with the fragments of copper too coarse to pass through the screen and the crushing efficiency would decrease until it became necessary to stop and clean out the mortar. This was formerly the case, but an ingenious device has obviated the difficulty. Part of the water needed in the battery is admitted through a hydraulic jet 5 inches in diameter, opening near the die. The flow of this jet is so strong that the rock cannot sink down into the pipe, but the heavier copper does, thus making its escape from the mortar. This simple, easy, and efficient method of crushing material of this character could scarcely be improved upon. Efficiency in the steam-end of the machine was formerly secured by steeple compounding, but now the exhaust-steam is led to low-pressure turbines and utilized for the generation of electric energy.

The subsequent classification and concentration of the ore on tables can only detain us here because the tailing thus produced contains considerable quantities of copper; the Calumet & Hecla alone has accumulated 40,000,000 tons of tailing, impounded in Lake Linden, which contains 13 lb. copper per ton. In former years effort was chiefly directed in a vain attempt to recover more copper by a superabundance of buddles and other devices. Chiefly through the intelligent research work of C. H. Benedict, metallurgist for the Calumet & Hecla, it is now clearly recognized that the way to recover the copper contained in this coarse tailing is to first re-grind it so as to set the copper free. The Hardinge mill has been found most efficient for this re-grinding and it is now used for this purpose in many of the mills. No matter how efficiently done, fine grinding is rather expensive, and it is easy to see that the most finely disseminated copper will require for its liberation grinding to a degree which would be unprofitable, not to mention the fact that the recovery of this copper (which is in the form of extremely thin sheets lying along the cleavage planes of the minerals) would be difficult if not impossible. Mr. Benedict has therefore proposed to leach the tailing from the tables, following the re-grinding operation. As the ore contains too much calcite to render it possible to use an acid or the salt of an acid radical he therefore devised a clever modification of the reaction commonly used in laboratories for the absorption of oxygen through the action of ammonia and an ammonium salt on finely divided copper. A 2000-ton plant was in course of construction when the outbreak of the war, and the consequent fall in the price of copper, brought construction work to a standstill. The process, therefore, has not as yet proceeded beyond the laboratory stage. As an indication of what it is hoped to do it may be said that on tailing containing 13 lb. copper per ton it is expected to recover 5½ lb. by re-grinding and concentration on tables, and 70% of the remainder, or 5½ lb. more by leaching. The reduction in the copper content of tailing thus made possible corresponds to an equivalent decrease in the copper content of workable ore, in other words an enormous addition has been made to the ore reserves of the district.

The conclusion of the matter therefore is that progress is being made with all practicable speed toward the introduction of those changes in practice necessary to transform this interesting mining district into one that will be characterized by large-scale operations conducted at high efficiency and low operating cost. The development of new mines will be characterized by heavy initial expense, but the persistence and the productivity of the lodes form a strong attraction for the investment of the necessary capital. This district is not upon the decline; it bids fair rather to have just entered into a vigorous middle-age. That period which in men's lives is often the most productive of solid achievement.



DISCUSSION

Latent Errors in Mine-Sampling.

The Editor:

Sir—Mr. Morton Webber in his article in your February issue has drawn attention to a source of error in mine valuation that has possibly been productive of more disappointments in milling-results than any other. As a contribution to the discussion, I will detail a recent experience of my own that serves to confirm Mr. Webber's conclusions.

The orebody in question was composed essentially of two parallel quartz lodes impregnated with auriferous copper and arsenical sulphides in a matrix of hornblendic schist, the parting between these lodes containing sufficient gold to allow of the whole being stoped in one body, except at the extreme flanks of the ore-shoot where the lodes had to be exploited separately. The combined lodes formed a body varying from 8 to 20 ft. in width. The mine had been partly developed 10 years previously, and a number of cross-cuts driven through the orebody, the sampling records of which were available.

The whole of these workings were re-sampled, and it was found that although the average width and assay-value tallied fairly well with the previous results, individual cross-cuts showed marked discrepancies. By this time, as the result of further extensive development, a satisfactory tonnage was available, and accordingly before proceeding to the erection of a reduction plant the technical control decided to make a check sampling in bulk. The result of this was instructive. Altogether eight cross-cuts were stripped at various points in the mine, the ore amounting to 170 tons in all. This ore was crushed and carefully sampled at the lip of the mortar-box. Of the eight cross-cuts, the results obtained from four by this means corresponded closely with the mine sampling, three showed a substantial decrease, and one a substantial increase in value. The average reduction in value over the whole series amounted to approximately 11%, and this factor was adopted when estimating the value of the mine's ore reserves. The full reduction plant has now been in commission for over a year and a half, and this estimate has been confirmed by milling results. Had not this course been taken, the valuation of the mine would have been excessive, and severe disappointment occasioned to the shareholders.

I am strongly of opinion that in dealing with ores of this kind some such course as this should be adopted. The difficulty is occasionally met by other methods, such as by employing, in the estimation of ore reserves, only what are known as 'reduced' assay-values. In this case any abnormally high assays are reduced either to a fixed maximum or else to an average of the assays immediately preceding and succeeding the abnormal assays.

This method, however, brings a totally unknown factor into valuation, which to my mind cannot be considered satisfactory from the professional point of view. The figures which Mr. Webber has given in his article afford an excellent instance of this. The average of W's assays was $18·30 and of X's $18·29, and Mr. Webber considers that the discrepancy between mine-sampling and mill ore would not have been less than 10%. We will suppose that a sample crushing in bulk was made similar to the one detailed above, and that this factor was ascertained. Making the necessary deduction both W and X would report the same milling value for this body of ore, namely, $16·47.

In order to arrive at approximately the same result by means of reduced values, we will substitute the flat value of $26 for any assay exceeding that figure. W's sampling would then average $16·37, and X's sampling $17·19; W's would thus be approximately the true milling value of the ore, but X's would be $0·82 too high, a serious discrepancy. In order to bring X's down to the correct value we will now make the flat reduced value $24 for both series of assays, instead of $26. This would bring X's valuation to $16·55, but W's would be $15·63 or $0·92 too low. Nor would the intermediate figure, namely, $25 give any more satisfac-

tory results. W's average would be $16·18 or $0·29 too low, and X's $17·05 or $0·58 too high, in spite of the fact that originally their unreduced sampling results averaged practically the same.

It may be said that the publication of reduced values causes anticipations not to be too sanguine, while development is still proceeding, and before a complete valuation of the ore reserves can be made, and possibly for this reason it may serve a useful purpose. But once the principle has been admitted, human nature being what it is, the tendency is to play for safety, and in all probability under-estimate. To quote from the February editorial "an under-estimate is as much an engineering blunder as an over-estimate." True, but the result is not so fatal either to shareholders or to the responsible engineer's reputation. For this reason I am convinced that in dealing with ores of this description the only satisfactory procedure is to utilize all assays in calculating the value of the ore and subsequently to correct the estimate by means of the factor derived from a trial-crushing in bulk.

ALEX. D. JOHNSON.

Plymouth, March 15.

Ore.

The Editor:

Sir—I have read with much interest your article on 'Ore,' in the January issue of the Magazine, but I do not think that, even yet, the opposition will be satisfied.

I admit that a satisfactory definition must take into consideration the element of economic value; but such value must be independent of adventitious conditions. The object of technical names is surely to designate things as definitely as possible, and without reference to non-essential conditions that may happen to surround them. Admitting, as most of us do, that economic value is part of our conception of ore, we do not see that the thing, ore, ceases to be ore if you change its surroundings, or lessen its quantity. A piece of solid chalcocite is 'ore' to us, whether it occurs at Butte or in Central Africa. If our directors want to know if we have 'struck ore' in a certain working, are we to reply, "we have struck something, but whether or not it is 'ore' will take us $50,000 and six months to find out?" To require us to take into consideration, before using a name, conditions foreign to the thing itself, is to take away half the value of words of precision.

I respectfully repeat the suggestion: "Ore is rock from which, when occurring in sufficient quantity and under suitable conditions, metal can be extracted with economic advantage."

GEORGE E. COLLINS.

Denver, Colorado, February 23.

Pyrite or Pyrites.

The Editor:

Sir—In an Editorial Note last month you told your readers not to miss my remarks on the nomenclature of the various sulphides of iron, copper, and arsenic, made in introducing my paper on 'Gold in Ashanti' before the meeting of the Institution of Mining and Metallurgy, which would in the ordinary course of events be published in the report of the discussion on the paper in the March Bulletin. Unfortunately for your readers, my remarks have not been published in the way expected, so I take advantage of the hospitality of your columns to send you an outline of my remarks.

In using the word 'pyrite' I mean a definite mineral, iron disulphide crystallizing in the cubic system. The word is derived from the Greek πυρ, fire, through πυριτης meaning of, in, or concerning fire. The Greek πυριτης, however, did not mean pyrite. This mineral had no special name in those days, but was included with numerous other substances that strike fire with steel under the generic name πυριτης λιθος.

I have been told that 'pyrite' is of American origin, and, therefore, objectionable. The Americans certainly use it, but the word did not originate in America, and the Americans are in very good company in the use of it.

Most European languages use a name of similar origin to ours for iron disulphide, and the only people who use the terminal 's' are the Portuguese. I have consulted most British authorities on mineralogy and I regret that the majority prefer the word 'pyrites.' Professor Grenville Cole is a notable exception. When standing alone they spell it 'pyrites,' when it is qualified by an adjective preceding it they also use the terminal 's,' but note the inconsistency: when a prefix is attached, the terminal 's' is dropped, as in 'chalcopyrite,' and when, to form even the simplest derivatives an affix is used, the 's' invariably disappears, as in pyritic, pyritiferous. Could anything be more absurd or irrational?

Let us next see what meaning the word 'pyrites' conveys? If an engineer informs me that 'pyrites' occurs in an ore, I do not know exactly what he means, in fact no one knows. If he speaks accurately he probably

refers to either cubic or rhombic iron disulphide, but he possibly may mean magnetic 'pyrites,' arsenopyrite, or chalcopyrite. Now this is quite wrong. Every word should convey a definite meaning, be its significance wide or narrow. In short, according to both common usage and mineralogical authorities, the word 'pyrites' is ambiguous, and we are consequently in the position in England now of having no mineral name by which to indicate unequivocally the commonest sulphide occurring in nature. The word 'pyrite' used by a few now should be accepted by all as the name for cubic iron disulphide. Its termination harmonizes with that of the names of the majority of minerals in most languages, and (except that the British Museum does not appear to have adopted it) there is no objection to its acceptance that is worth a moment's consideration. The Encyclopædia Britannica says that 'pyrites' includes both the cubic and rhombic forms, and does not mention 'pyrite.' The Oxford Dictionary, however, supports my contention, and, incidentally, it explodes the American bogie. I extract the following information from it: 'Pyrite' or 'Pyrit' is an old English word; it appears in works by Maplet in 1567, by Green in 1588, 1589, and 1590, by Holme in 1688, and by E. Darwin in 1791, so England was using the 'American' word before the *Mayflower* sailed. This standard dictionary defines 'pyrite' mineralogically as "native iron disulphide crystallizing in isometric forms . . . . one of the forms of iron pyrites."

It should be the aim of scientific men in all countries to make the terminology of science as nearly identical as possible in all languages, and in this respect a great measure of success has been achieved already. It is discreditable to our British institutions that we so often lag behind.

J. Morrow Campbell.

Wallington, Surrey, March 24.

The Mining of Alluvial Deposits.

The Editor:

Sir—The authors of the valuable series of articles now appearing in your columns make some statements with regard to the duty of water that are open to criticism. Referring to hydraulicking on page 93, they say: "Within limits the amount of water required varies inversely with the head obtainable. With a 200-ft. head, a flow of 2000 inches would suffice to operate a moderately sized mine, while with a 400-ft. head, 1000 inches would give nearly the same output, the gravel being free and loose. . . . . The duty of water in cubic yards per miner's inch varies from one to ten, and depends upon the character of the gravel, the facility for disposal of tailing, the amount and head of water obtainable."

Compare C. W. Purington (loc. cit. p. 134). "It is a common fallacy among men inexperienced in hydraulicking that an increase in head will increase the amount of gravel that can be moved to the sluice. It must be remembered that the force of water imparted by head is entirely expended in piping against the face, while the sluice is the governing factor in the moving of gravel after it leaves the face. The aid given by the water in moving gravel to the sluice, and in it, is dependent on the grade over which it runs."

Unqualified acceptance of the authors' views on this point would certainly lead to unjustifiable expense being incurred to obtain and employ water under head where available gradient is the dominant factor in limiting output.

R. T. Hancock.

Wembley, February 20.

Statistics of Transvaal Gold Production.

The Editor:

Sir—In the statistics published by you in the issue of January 1915, certain figures of "Cost and Profit on the Rand" are given, and under them a note occurs as follows: "The above are the official statistics published by the Transvaal Chamber of Mines. They understate the cost by about 15%, and overstate the profit by about 30%."

It is true the figures in the columns under the headings 'cost per ton' and 'profit per ton' are quotations from the official statistics published by the Transvaal Chamber of Mines, but these headings are not. The word 'working' is omitted before 'cost' and 'profit' respectively, and is not irrelevant in view of the above comment. The Chamber does not purport to publish figures of 'cost' or 'profit' but only figures of 'working cost' and 'working profit,' and, further, in publishing these figures, the Chamber details the principal items of cost that are not included in the working costs so published. At the foot of each page of the Chamber's monthly analysis of gold production, the statement is made that "gold held in reserve, expenditure charged to capital account, interest on and redemption of debentures, and profits tax, have not been taken into account in the working costs and profits."

A cursory examination, therefore, of the

Chamber's monthly analysis shows clearly that the figures do not, and are not intended to, represent total expenditure and divisible profit, as might be believed from your note above quoted, but represent what they are published as representing, namely, working costs and working profits.

I notice that in your issue of March, 1915, the part of the note above referred to, to which exception is taken, is omitted, and that other words have been substituted; also that the heading of the final column has been corrected and now appears as 'Working Profit' instead of as previously 'Total Profit.'

May I ask you to be good enough to publish this letter, and to correct the headings of the third and fourth columns by adding the word 'working' in both cases.

A. R. GOLDRING.

Transvaal Chamber of Mines,
London Office, March 23.

[We shall willingly add the word 'working' to the headings of the columns giving the cost and profit per ton, as suggested, but we shall continue to add the footnote, as in the March issue, stating that the profits available for distribution among shareholders are about 70% of the 'working profit,' otherwise the figures would be misleading.—EDITOR.]

The Berenguela Tin District.

The Editor:

Sir—In the article under the above heading that appeared in the Magazine for December 1914, the table giving the scale of wages then ruling in the Berenguela district was omitted. As the wages question has an important bearing on the cost of production and other economic considerations, I give this table herewith.

RATE OF WAGES.

A Bolivian Dollar = about 18d.

	Bs. per shift of 12 hours.
MILL HANDS.	
Mayordomo	3·50
Trammers	1·80 to 2·30
Wheel-barrowers	1·50
Buddle-girls	0·40 to 1·20
Buddle-dischargers	2·00 to 2·20
Kieve men	3·00 to 3·50
Battery-feeders	1·80 to 2·40
Table-hands	1·00 to 3·00
Diesel motor-men	2·80
Ore-sorters (women)	1·00 to 1·20
Jig-men	2·40 to 2·50
Carpenter	4·00 to 4·20
Blacksmith	4·00 to 5·00
Blacksmith helper	2·40
Night watchman	2·00
Mechanic	6·00 to 7·00
HAND-INGENIO.	
Quimbalete-men	2·40 to 2·80
Maritata-men	2·60

A 'quimbalete' is an appliance for crushing ore; a kind of rocking stone. They are also made of iron.

A 'maritata' is a hand jig. The waste is skimmed off the tray and only the very fine stuff passes through the screen.

	Bs. per shift of 12 hours.
MINE HANDS.	
Mayordomo	3·00 to 4·00
Miners	2·20 to 3·30
(Most of them 2·60 to 3·00)	
Trammers	2·40 to 3·60
Apiri (shovellers)	1·50 to 3·00
Pongo (dry-waller)	2·60 to 4·00
Mason	3·50 to 4·00

The above are the extremes of wages ruling on the Berenguela, Tucsuhuma, and Jatunkaka Mines. When contracts are given, the men make more per shift, but do more work.

I take this opportunity of reminding your readers that the article was written before the outbreak of war, and that the prices and costs mentioned by me do not refer to the present abnormal conditions.

By the way, the flow-sheet accompanying the article was wrongly labelled as that of the Tucsuhuma mill. Its title should have been 'Flow-Sheet of the Berenguela Mill'; the reference in the text was correct.

HAROLD ALLMAN LEWIS.

Potosi, Bolivia, January 30.

Leaching with Ammonia.

The Editor:

Sir—To your issue of February, Mr. J. D. Audley Smith contributed an interesting account of his experiments with the use of ammoniacal solutions for leaching copper ores at the mine of the Arizona Copper Company. His results were such as to indicate that the method could not be successfully applied to those ores; in particular it was found that 4% of the ammonia escaped in the atmosphere and that this loss constituted a serious item of cost. The inference from these results is that the outlook for successful operation of the plant now being built by the Calumet & Hecla Mining company at Hubbell, Michigan, is somewhat dubious, and it will be well, therefore, to point out that the cases are not similar. The solutions which Mr. Audley Smith used contained 3·36% of NH_3, but the solutions to be used in the Calumet & Hecla plant contain less than half this amount of ammonia. It is evident that the loss of ammonia from weak solutions would be much less than from stronger ones. Another point of importance is that the elevation at Clifton, where Mr. Audley Smith's experiments were made, is 3450 ft., while the elevation at Hubbell is only a little over 700 ft., producing a corresponding differ-

ence in atmospheric pressure, with its obvious effect on the escape of a gas from a solution. Finally, there is an equally great difference between the mean annual temperatures of the two places, though exact figures are not to hand, and this also would tend to produce less loss at Hubbell. No official statement has been made concerning the Calumet & Hecla plant, but it is unofficially known that the comprehensive series of experiments made there showed no appreciable loss by escape into the atmosphere, the unimportant losses which take place having been traced to adsorption on the sand particles and incomplete displacement in washing. The large vats to be used for leaching will probably almost completely eliminate the latter source of loss. The vats will be covered and the circulation of solutions so arranged that there will be a slight tendency toward a vacuum within them, thus drawing in through vents the air which is necessary for the reaction between the copper and ammonia. It is readily seen that with such an arrangement the tendency of the ammonia to escape would be at a minimum.

The corrosion experiments conducted by Mr. Audley Smith also indicated that trouble might be expected from the attack of the solution on the steel vessels used. Here also the experience in the experiments at Hubbell was the reverse, and no appreciable effect on the steel was noticed at the conclusion of the experimental work. Even if it should prove true in practice that the steel is corroded it would not be a serious matter, as a great variety of protective paints are now available, at reasonable prices, that will doubtless overcome the possible difficulty. The ore of the Calumet & Hecla seems to be specially adapted to treatment with ammonia, and it must not too hastily assumed either that a method which proves successful there may be successfully applied elsewhere, or that difficulties encountered elsewhere will necessarily prove troublesome at Hubbell. The real difficulty so far developed is in the treatment of the slime, and this is discreetly being left for solution until after the leaching of the sand has been successfully accomplished.

THOMAS T. READ.

New York, March 20.

The Gold produced in the Philippine Islands during 1914 is officially estimated, by the Bureau of Science at Manila, at $1,203,433, as compared with $868,362 the year before. The yield is about equally divided between dredging and lode-mining.

German Pig Iron.—The figures published by the *Iron and Coal Trade Review* show the effect of the war on the production of pig iron in Germany. The total output during 1914 was 14,389,547 tons as compared with 19,309,173 tons during 1913. The following table gives the monthly output during 1914, and it will be seen that after the sudden drop in August and September, the rate of output began to increase again.

MONTHLY OUTPUT DURING 1914.

Month.	Tons.	Month.	Tons.
January	1,566,505	August	586,661
February	1,445,511	September	580,087
March	1,602,896	October	729,822
April	1,534,429	November	788,956
May	1,607,193	December	853,881
June	1,531,313		
July	1,564,345	Total	14,389,547

The following table gives the production according to districts.

PRODUCTIONS ACCORDING TO DISTRICTS.

	Tons. 1913.	Tons. 1914.
Rhenish-Westphalia	8,209,157	6,610,119
Siegerland and Hessen-Nassau	994,927	702,436
Silesia	994,604	853,957
North and Central Germany	1,001,321	734,659
South Germany and Thuringia	320,456	266,065
Saar District	1,370,980	954,738
Lorraine and Luxemburg	6,417,727	4,267,573
Total	19,309,172	14,389,547

The United States Steel Corporation's report for 1914 shows a big drop in production and profits as compared with the previous year. The following table gives details:

	1913 Dollars	1914 Dollars
Earnings	147,166,616	81,746,517
less Interest on Bonds, etc., of Subsidiary Companies	9,985,271	10,082,902
less Depreciation	23,972,376	17,044,183
less Sinking Funds for Bonds of Corporation and Subsidiary Companies	8,671,592	9,018,554
less Interest on Corporation's Bonds	22,532,690	22,239,086
Net Profits	81,216,985	23,496,768
Dividends on 7% Preference Stock	25,219,677	25,219,677
Dividends on Common Stock	25,415,125 (5%)	15,249,075 (3%)
Deficit for 1914	—	16,971,983
Surplus Profit for 1913	30,582,183	—

OUTPUT OF CHIEF PRODUCTS.

	1913 Tons.	1914. Tons.
Iron Ore	28,738,451	17,034,981
Coal	30,786,573	21,162,293
Coke	16,663,480	11,173,914
Pig Iron	14,080,730	10,052,457

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	Mar. 1 1915	April 1 1915
RAND:			
Bantjes	14	10	11
Brakpan	51	49	51
Central Mining (£12)	160	119	122
Cinderella	6	4	4
City & Suburban (£4)	52	44	49
City Deep	66	55	58
Consolidated Gold Fields	43	27	29
Consolidated Langlaagte	35	31	34
Consolidated Main Reef	18	17	18
Crown Mines (10s.)	120	82	85
Durban Roodepoort	21	20	21
D. Roodepoort Deep	17	15	15
East Rand Proprietary	33	29	34
Ferreira Deep	47	44	45
Geduld	23	22	24
Geldenhuis Deep	26	22	22
Heriot	55	60	61
Jupiter	5	4	5
Kleinfontein	24	21	24
Knight Central	8	6	6
Knight's Deep	35	20	21
Langlaagte Estates	20	18	18
Luipaard's Vlei	10	7	7
Main Reef West	7	6	8
Meyer & Charlton	115	101	102
Modderfontein B	89	88	93
Modderfontein, New (£4)	263	254	269
Nourse	27	21	22
Primrose	21	12	13
Rand Mines (5s.)	120	88	94
Randfontein Central	17	12	13
Robinson (£5)	57	31	36
Robinson Deep	33	26	26
Rose Deep	43	35	36
Simmer & Jack	12	8	9
Simmer Deep	1	1	1
Springs	11	16	20
Van Ryn	67	59	59
Van Ryn Deep	47	45	46
Village Deep	40	35	36
Village Main Reef	40	30	31
Witwatersrand (Knight's)	71	57	59
Witwatersrand Deep	48	39	39
Wolhuter	14	13	13
RHODESIA:			
Cam & Motor	19	16	15
Chartered	17	11	12
Eileen Alannah	11	10	9
Eldorado	18	14	15
Enterprise	9	4	5
Falcon	14	11	11
Giant	14	7	8
Globe & Phœnix (5s.)	32	31	30
Lonely Reef	27	26	24
Shamva	46	36	37
Wanderer (5s.)	3	2	3
Willoughby's (10s.)	7	5	6
OTHERS IN SOUTH AFRICA:			
De Beers (£2 10s.)	330	199	240
Glynn's Lydenburg	11	11	10
Jagersfontein	78	52	60
Premier Diamond (2s. 6d.)	152	75	102
Sheba (5s.)	4	3	4
Transvaal Gold Mining Estates	37	37	37
WEST AFRICA:			
Abbontiakoon (10s.)	8	9	9
Abosso	14	7	9
Ashanti (4s.)	16	15	15
Broomassie (10s.)	2	2	2
Prestea Block A	15	12	12
Taquah	15	14	15
WEST AUSTRALIA:			
Associated Gold Mines	7	5	5
Associated Northern Blocks	7	5	5
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	50	50
Great Boulder Proprietary (2s.)	14	17	16
Great Boulder Perseverance	2	2	2
Great Fingall	9	5	7
Ivanhoe (£5)	50	46	59
Kalgurli	36	37	37
Sons of Gwalia	23	21	19
Yuanmi	3	2	2

	July 1 1914	Mar. 1 1915	April 1 1915
OTHERS IN AUSTRALASIA:			
Blackwater	16	15	15
Consolidated Gold Fields of N.Z.	13	11	11
Mount Boppy	10	11	11
Mount Morgan	52	46	47
Progress	10	5	6
Talisman	33	30	27
Waihi	42	41	44
Waihi Grand Junction	25	24	25
AMERICA:			
Alaska Treadwell (£5)	162	140	145
Buena Tierra	15	14	13
Butters Salvador	20	10	10
Camp Bird	9	7	6
Canadian Mining	—	9	9
Casey Cobalt	13	6	8
El Oro	14	9	8
Esperanza	15	10	9
Granville	10	—	—
Kirkland Lake Proprietary	74	34	31
Mexico Mines of El Oro	97	82	75
Oroville Dredging	10	12	12
St. John del Rey	15	15	15
Santa Gertrudis	11	11	8
Tomboy	22	23	24
Tough-Oakes	28	13	14
RUSSIA:			
Lena Goldfields	43	31	36
Orsk Priority	7	—	—
Siberian Proprietary	3	—	4
INDIA:			
Champion Reef (2s. 6d.)	11	11	11
Mysore (10s.)	93	85	86
Nundydroog (10s.)	27	25	26
Ooregum (10s.)	23	25	27
COPPER:			
Anaconda (£5)	126	104	119
Arizona (5s.)	36	—	—
Cape Copper (£2)	60	55	55
Chillagoe (10s.)	1	½	½
Cordoba (5s.)	6	3	3
Great Cobar (£5)	3	3	1
Great Fitzroy (5s.)	½	¼	¼
Hampden Cloncurry	27	24	25
Kyshtim	55	44	53
Messina (5s.)	15	12	10
Mount Elliott (£5)	55	71	70
Mount Lyell	23	23	26
Rio Tinto (£5)	1355	1165	1205
Sissert	25	22	24
South American Copper (2s.)	22	12	13
Spassky	52	40	41
Tanalyk	78	46	54
Tanganyika	40	29	29
Tharsis (£2)	125	—	—
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	28	20	24
British Broken Hill	36	25	27
Broken Hill Proprietary (8s.)	36	37	41
Broken Hill Block 10 (£10)	32	24	26
Broken Hill Block 14 (25s.)	6	—	—
Broken Hill North	52	42	46
Broken Hill South	175	140	145
Sulphide Corporation (15s.)	26	17	19
Zinc Corporation (10s.)	19	14	15
ASIA:			
Burma Corporation	28	31	31
Russian Mining	31	18	22
Russo-Asiatic	151	80	106
TIN:			
NIGERIA:			
Bisichi	8	7	8
Jos (5s.)	5	5	5
Kaduna (5s.)	15	15	15
Naraguta	17	17	17
N. Nigeria Bauchi (10s.)	3	1	1
Rayfield	5	4	5
Ropp (4s.)	100	17*	17*
OTHER COUNTRIES:			
Aramayo Francke	31	27	27
Briseis	5	5	6
Cornwall Tailings	17	12	15
Dolcoath	11	8	8
Geevor (10s.)	5	4	4
Gopeng	27	27	29
Mawchi	20	4	4
Pahang Consolidated (5s.)	7	6	7
Renong Dredging	36	22	21
Tekka	55	55	60
Tronoh	26	30	32

* Denomination of shares recently changed from £1 to 4s.

PRECIS OF TECHNOLOGY

[*Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.*]

Metallurgical Progress at Anaconda.—*The Anode* is the name of a new paper, published monthly by the Anaconda Copper Mining Company, at Butte, Montana. In the February issue, Frederick Laist, the metallurgical manager for the company, gives an official statement of the intended improvements to be introduced at the Washoe concentration and smelting plants and at the Great Falls smelting and refining plants. These improvements are estimated to cost six million dollars. They are expected to increase the extraction and to decrease the cost, with the result, that not only will the profits be greater but that ore of lower grade can be profitably worked, thereby considerably prolonging the life of the mines. The most notable new departure is the introduction of the flotation process, to which we referred in our Review of Mining last month. By this means it is hoped to raise the percentage of recovery from 78 to 91. Alterations are also being made in the present plant, to suit the new plan of concentration. A Symons disc crusher will be added to each section in order to increase the capacity of the crushing department from 12,500 to 15,000 tons per day. The jigs on the roll and Huntington-mill floors will be removed and replaced by roughing tables, which will produce concentrate and coarse tailing. This tailing will be re-ground in pebble-mills to pass 60-mesh, and sent to the flotation plant, which will produce a concentrate averaging 8% copper, with a final tailing averaging 0·1% copper. The slime that is now treated on round tables will be further treated by flotation. Under this new system the whole of the output of the mines will go to the concentrators instead of some of the ore being picked and sent direct to the blast-furnaces. Moreover no coarse concentrate will be produced, suitable for the blast-furnaces. Consequently the applicability of the blast-furnace is greatly restricted, if not entirely eliminated. As the various concentrates will go to reverberatories instead of partly to blast-furnaces, it is necessary to provide additional roasters. The additional roasting plant will contain 40 furnaces, each 22½ ft. in diameter. These will be charged by a conveyor-belt system instead of by cars. The reverberatory capacity will be increased by 150%. The new furnaces will be 150 ft. long by 25 ft. wide, and will smelt 650 tons per day each. Coal-dust fireing will be adopted throughout, on the system described by E. J. Carlyle in our issue of September last.

The barrel-shaped converters at Washoe are being replaced by large upright converters of the Great Falls type, measuring 20 ft. in diameter. Seven of these are to be erected, having an aggregate capacity of 10,000 tons of copper per month. The slag from the converters, which is now solidified and re-smelted in blast-furnaces, is to be sent direct in a molten condition to a big reverberatory 175 ft. long and 25 ft. wide, where it will be treated along with fine ore. The capacity of this reverberatory will be 700 tons of molten slag and 350 tons of fine ore per day. By this treatment the slag will be cleaned to such an extent that it may be allowed to run to waste. The blast-furnaces and briquetting plant, though discarded for general use, will be kept in working order, so that during periods of high prices for copper they may be requisitioned in order to push production.

The new leaching plant for re-treating accumulated tailing should be ready this month, April. The amount to be treated is about 15 million tons, and averages from 13 to 14 lb. of copper per ton. From 2000 to 2500 tons will be treated per day, and the output should be about 3000 tons per month. The new acid works is nearing completion. Its capacity will be over 100 tons of sulphuric acid per day. The acid will be used in the leaching plant and in the flotation plant.

The above information refers to the Washoe plant. As regards the Great Falls plant, a new refinery is to be built, with a capacity of about 5000 tons of copper per month, or just double that of the present refinery, which is old and out of date. The blast-furnaces will be closed and coal-fired reverberatories substituted. No concentration will be done at Great Falls.

The Origin of Kaolin.—In the new book on 'Kaolin,' reviewed in another column, the author, J Allen Howe, discusses at some length the various theories that have been evolved for the purpose of explaining the origin of kaolin. All these theories are based on the decomposition of felspar in granite or other igneous rock by the agency of carbonic acid and water, the function of the carbonic acid being the removal of the alkali or alkaline earth. The theories may be divided into six groups according to the action of: (*1*) surface weathering, (*2*) waters descending from swamps and bogs, (*3*) ascending waters containing carbonic acid, (*4*) emanations following igneous activity, (*5*) sulphuric acid solutions and sulphuretted hydrogen, and (*6*) hydrolysis. The first is the oldest of the theories. It was promulgated by Werner, of Freiberg, over a hundred years ago, and it still finds a place in the text-books. The objection to the theory is that so small a proportion of granite throughout the world and in each individual deposit is associated with kaolin, and that, in fact, surface-weathering does not normally produce true kaolin at all. The second theory was also evolved in Germany, where the deposits are often small and are associated with various carbonaceous formations. Mr. Howe considers that this theory may explain certain shallow formations lying on igneous rocks, but not the origin of the deep kaolins of the West of England. Similarly, the third theory, that of ascending waters containing carbonic acid, may explain a limited number of cases. The fifth theory, that of sulphuric acid and sulphuretted hydrogen, has had much vogue in America, where the acid solutions due to the decomposition of sulphides have been shown by Lindgren, Ransome, and others to be the cause of the formation of kaolin in metalliferous lodes. The circumstances are, of course, different from those of the big deposits of kaolin, and Mr. Howe calls for more examination of this theory before attempting to apply it generally. The sixth theory, reviewed recently by Cameron and Bell of the United States Department of Agriculture, seeks to show that silica was removed from felspar by hydrolysis. The carbon dioxide would unite with the released alkali or alkaline earth, and form a compound more soluble than the dissolved felspar or the kaolin, and thus readily removed. Mr. Howe is not, however, impressed with the opportunities for the removal of these basic products afforded by this theory. We have left to the last the consideration of the fourth theory, as it receives Mr. Howe's special attention in connection with the deposits in Cornwall and Devon. The pneumatolytic theory was first proffered on account of the presence of fluor-spar in certain deposits of kaolin. Among other upholders of the theory is J. H. Collins, who is of opinion that fluorine is the principal kaolinizing agent. Rösler has pointed out that other minerals such as tourmaline, topaz, siderite,

and pyrite not found in the unaltered granite are often observed in the kaolin, so that some secondary action must have taken place other than those described in the preceding theories. Mr. Howe does not accept the supposition that the fluorine and boron of tourmaline, topaz, and fluor-spar had anything to do with the kaolinization, but holds that the carbonic acid, characteristic of the later stages of pneumatolytic and hydatogenetic action, provides the explanation of the formation of the kaolin. His theory applies only to the deep and massive bodies found in the West of England. In his general summary of the subject, he submits that carbonic acid is the principal agent in kaolinization, though its action may have been applied not only in pneumatolysis, but in the other ways described.

Bolivian Tin Producers.—In the *Engineering and Mining Journal* for March 6, M. G. F. Söhnlein gives a list of tin mines and producing companies in Bolivia, together with rough estimates of the monthly outputs. These are segregated according to ownership, Mr. Söhnlein's object being to show that by far the larger proportion are owned locally by Bolivians and Chileans, and to correct a prevalent idea that the tin output of Bolivia is extensively controlled by English and German capital. The figures do not fully indicate the smallness of the proportion of outside capital involved, for, properly speaking, Aramayo Francke cannot really be included among English interests. It is true that the company is registered in England and that Mr. Aramayo lives in London, but he developed the properties and provided the capital while still resident in South America. Mr. Söhnlein, in his figures for output, uses the 'quintal.' We take it that this is the Spanish quintal, not the metric measure. For the benefit of English readers we use the hundredweight instead. Though Mr. Söhnlein's range of minimum and maximum may be warranted in individual cases, we would say that for the totals the minimum figures are much nearer the mark.

MINES OWNED IN BOLIVIA.

Mine	Department	Owner	Monthly Production Concentrate Cwt. Min.	Max.
Uncia	Potosi	S. I. Patiño	20,000	25,000
Huanuni	Oruro	S. I. Patiño	5,000	8,000
Cerro Rico de Potosi	Potosi	Various	2,000	3,000
Andacaba	Potosi	Quesada Alonso	1,000	2,000
Avicaya	Oruro	Abelli & Cia. (Banco Argandoña)	1,000	1,500
Many small mines, alluvial workings, and dumps		Various	1,500	2,000
		Total	30,500	41,500

COMPANIES CONTROLLED IN CHILE.

With offices in Santiago.

Company	Department	Monthly Production Concentrate Cwt. Min.	Max.
Estanifera de Llallagua	Potosi	8,000	15,000
Minera de Oruro	Oruro	2,500	3,500
Minera San José de Oruro	Oruro	800	1,000
Estanifera de Totoral	Oruro	800	1,000
Minera de Colquiri	Oruro	800	1,000
Minera de Monteblanco	La Paz	500	1,000
Minera Oploca	Potosi	2,000	3,000
Minera de Antequerra	Oruro	300	500
	Total	15,700	26,000

ENGLISH COMPANIES.

Company	Department	Monthly Production Concentrate Cwt. Min.	Max.
Aramayo Francke	Potosi	6,000	7,000
Porco Tin Mines	Potosi	500	800
Royal Silver Mines	Potosi	500	1,000
Berenguela Tin Mines	Cochabamba	300	500
Penny & Duncan (Morococala)	Oruro	2,000	3,000
Duncan, Fox & Co. (Nané)	Oruro		300
	Total	9,300	12,600

MINES OWNED BY OTHER OUTSIDERS.

	Monthly Production Concentrate Cwt. Min.	Max.
Lower levels in Cerro Rico de Potosi, L. Soux (French)	3,500	4,000
Cerro Rico de Potosi, Bebin Hermanos (French)	800	1,000
Huayna Potosi, Dept. La Paz (French)	1,000	1,500
Araca, Dept. La Paz, Harrison & Böttiger (German)	2,000	3,000
Jatuncaca, Dept. Cochabamba, Schlüter & Co. (German)		300
Catorce, Dept. Cochabamba, Mr. Nicolai (German)	100	200
Ocuri, Province Charcas, Mr. Weisser (German)		300
Tucsuhuma, Dept. Cochabamba (an Argentine company)	300	500
Total	7,700	10,800

TOTAL MONTHLY PRODUCTIONS.

	Concentrate Cwt. Min	Max.	Percentage of Total.
By Bolivian Companies	30,500	41,500	46
By Chilean Companies	15,700	26,000	28
By English Companies	9,300	12,600	14
By French Companies	5,300	6,500	7
By German Companies	2,100	3,800	4
Total	63,204	90,900	—

Minerals in German East Africa.—The *Bulletin* of the Imperial Institute for December last contains the first of a series of articles on the economic resources of the German colonies. This describes German East Africa, and it is illustrated with the map herewith reproduced. Most of the country consists of a plateau varying in altitude from 3000 to 4000 ft., and ending abruptly at a distance of 10 to 30 miles from the coast. The extinct volcano, Kilimanjaro, in the northeast, rises to a height of 19,321 ft., and is the highest point in the whole of Africa, Ruwenzori, in Uganda, being nearly of the same altitude. Stretching from this peak southeasterly to the sea are several ranges of mountains. On the southwestern side, adjoining Lake Nyasa, are the Livingstone mountains, the highest of which is 9000 ft. above the sea. Portions of the great African lakes, Victoria Nyanza, Tanganyika, and Nyasa, are included within the territory. The country is well watered, and the Rufigi and Rovuma are important rivers. The chief towns are Dar-es-Salaam, on the coast, which is the seat of Government, and Tabora, inland. Two railways have been built, one from Tanga to the foot of Kilimanjaro, and the other from Dar-es-Salaam to Lake Tanganyika. As regards the geology, the coastal plain is composed of Tertiary, Cretaceous, and Jurassic strata, covered in places by alluvium. The in-

terior plateau forms part of the great central tableland of Africa, and consists of ancient metamorphic rocks, such as gneiss and schist, through which in places granite and other igneous rocks have intruded. In some parts, troughs of residual Karoo beds are found, and on the northeastern side of Lake Nyasa these beds contain coal and oil-shale. In the north, between Victoria Nyanza and Kilimanjaro, igneous rocks rich in soda are found, and trona, that is natural carbonate of soda, forms a crust on Lake Natron. Over the boundary in British East Africa is the famous Magadi soda deposit.

MAP OF GERMAN EAST AFRICA.

The mineral resources of German East Africa have not been developed to any great extent. No important surface deposit of metalliferous mineral has been found. The chief mining operations have been in connection with mica, of which large quantities have been exported to Germany, to be used for insulation purposes in connection with electrical machinery. Uranium minerals have been mined and despatched to Germany. Hematite and magnetite are found in many places, and in large quantities in the western part of the territory. Surface deposits of laterite type have been worked and the ore has been smelted in a primitive way by the natives in the regions near Lake Nyasa. No deposits of lead or copper have been disclosed. Alluvial gold is found in streams flowing into the Indian Ocean and into the Victoria Nyanza. Deposits have been worked in the Muansa district, on the southern side of Victoria Nyanza, and at Iramba, 160 miles to the southeast of Muansa. In the Iramba district auriferous quartz veins are found, but they are usually small and variable in content. At the surface they are often rich in gold, but rapidly become poorer in depth. Similar lodes have been found at Ikoma, 150 miles east by north of Muansa. At Ussongo, near Tabora, the existence of a ferruginous breccia carrying 1 oz. of gold per ton has been noted. The chief gold mine is at Kironda, in the Iramba plateau, where stamps and cyanide plant have been erected. The latest available report is that for 1912, which shows that gold worth £23,000 was extracted. The general conclusion to be drawn from this article is that the mineral resources of the region deserve closer investigation.

Gold-Refining.—In his presidential address to the Institution of Mining and Metallurgy, Sir Thomas K. Rose reviewed the history of the processes for refining gold-bullion and compared their relative advantages. We extract references to W. A. Caldecott's experiments and to the history of the application of electrolysis. On the outbreak of the present war, propositions were made to re-establish the coining of South African gold at Pretoria, which had been discontinued

since the Boer war. W. A. Caldecott was asked by the Union Government to investigate with a view to introducing a suitable refining process. Transvaal gold is 860 fine, the alloying metal being chiefly silver. It was necessary to remove some of this silver in order to bring the gold up to standard 916. Dr. Caldecott decided to use the method described by him in 1902 in which permanganate of potash is substituted for the nitre in the old cementation process. He found that the time occupied in carrying the silver into the slag was too long if granulated bullion was used, owing to the comparatively small surface of the metal granules. Subsequently he worked direct on the finely divided gold-zinc slime after calcination. The fusion charge consisted of 100 parts of the calcined slime, 30 parts of manganese dioxide, 30 parts of sand, and 30 parts of calcined borax. After fusion, the charge was poured into conical moulds. The resulting buttons were granulated and fused with 20% of permanganate of potash, together with some sand and borax, in order to remove residual traces of zinc, lead, etc. The trials yielded bullion ranging from 926 to 950 parts of fine gold per 1000. This was alloyed with copper to make bars of standard fineness, and these proved to be perfectly malleable and ductile, and suitable in all respects for coinage. The subsequent action of the Bank of England in giving credit for gold bullion stored in South Africa made it unnecessary to proceed with the scheme for coinage. In congratulating Dr. Caldecott for his work, Sir Thomas Rose expresses a doubt whether a process using such dangerous reagents is suitable for general application.

As regards the introduction of the electrolytic refining of gold in a chloride bath, the records at the Royal Mint contain a communication dated 1863 from Charles Watt, of the Sydney Mint, to Thomas Graham, at that time Master of the Royal Mint. Watt used a solution to which he added "from one-fourth to one-fifth of its bulk of hydrochloric acid." This he added until bubbles of chlorine ceased to be evolved from the anode. The original solution was to contain 0·5 oz. gold per pint, approximately the same as that recommended in 1874 by Wohlwill, of the Norddeutsche Affinerie at Hamburg. The voltage was 1·7 and the current density 400 amperes per square metre. The anodes were 0·1 in. thick, and were dissolved in 24 hours. Watt also described the electrolytic removal of gold from bullion in which silver greatly predominates, in a nitric acid solution, thus antedating the Moebius process devised in 1884, and introduced in the United States Mints in 1902. Watt's inventions were allowed to be neglected, largely no doubt owing to the absence of a convenient source of electric current. Had the dynamo been invented in those days, his propositions would have been received with greater favour. The records given by Sir Thomas Rose are sufficient to show that both the Wohlwill and Moebius processes were known some years before they were introduced by the chemists whose names are now identified with them.

Sir Thomas Rose discusses at some length the advantages and disadvantages of the various processes for refining and parting. At the present time, chlorine gas is used in Australia, electrolysis in America, and sulphuric acid in England and Europe. A great advantage of the electrolytic process is that platinum and palladium are recovered, and that objectionable metals such as lead, bismuth, selenium, and tellurium are readily removed. At the Royal Mint these objectionable metals cause trouble occasionally, though with care the difficulties can be overcome. Though the cost of refining by the electrolytic process is low, the great length of time occupied in the treatment adds a serious item of cost in the form of interest on the gold. The time varies from ten days to three weeks, and the cost in interest on the gold thus locked-up is double that of the treatment process. The general conclusion is that if the bullion contains metals worth recovering the electrolytic process is preferable; otherwise the sulphuric acid is the quickest and easiest.

Iron and Coal in South Russia.—In the *Iron and Coal Trades Review* for February 19, J. W. Revillon gives a history of the development of the iron and coal deposits in South Russia Large deposits of excellent hematite are found at Krivoy-Rog, iron-stone in the Coal Measures, lower-grade Oolite ore at Kertch, and manganese ore at Nicopol; while the coal deposits in the Donetz basin are among the most important in the world. A point of interest is that the iron industry of South Russia was founded by an Englishman, John Hughes.

The Russian Empire has been noted for centuries for its charcoal iron, and fifty years ago the production was 200,000 tons per year. Coal was first found in South Russia in 1784, when the Donetz deposits were discovered by Skarnakoff. The Government, being desirous of establishing an iron industry on the basis of smelting with coal, shortly afterward started to smelt local ironstone at Lugansk by means of this coal, but the enterprise was a complete failure. In 1845, the oolite ore at Kertch in Crimea was tried, also unsuccessfully. After the Crimean war, another attempt was made, this time at Korsoun in the Donetz basin, and 150 tons of iron was produced. Unfortunately the brick lining of the furnace was not sufficiently refractory, and the project had to be abandoned through lack of financial support for the necessary improvements. In 1866, the Government erected a smelter at Lisichansk, and the coke to be employed was to be made from local coal. On the erection of coke ovens, it was found that the coal was not of the coking variety, so the scheme came to nothing. In 1869 the Government decided that it was necessary to modify its policy for the development of the mineral resources of South Russia, and abandoning the idea of doing the work itself, granted a concession in the Donetz basin to John Hughes. The Government undertook to pay a subsidy of £3 per ton on all rails produced up to 5000 tons per year until 1881, and Mr. Hughes agreed to make at least 100 tons of pig iron per week and to supply the Government with not less than 2000 tons of coal per year. Mr. Hughes formed the New Russia Company in England for the purpose of working this concession, and raised £300,000 capital. By 1874 the company was making 7000 tons of pig iron per year, and by 1887 the output had risen to 50,000 tons per year. In the meantime the hematite deposits at Krivoy-Rog had been developed by a French company, and communications had been greatly improved by the building of railways. Moreover the Government had imposed a protective import duty. Under these circumstances other people were anxious to follow John Hughes in the iron industry. The Alexandrovsk was started at Ekaterinoslav, and the Kamenskoy works, near the same town, shortly after. In 1892 the Krivoy-Rog Iron Ore Company erected a blast-furnace, and in 1894 the Droughkovka works was started. At the present time, 18 plants are in operation, having an aggregate output of 3,000,000 tons of pig iron per year, equal to 70% of the total production of the Russian Empire. It is interesting to note that of these works only two are

situated in the neighbourhood of the iron or coal deposits, namely, the works at Krivoy-Rog and Kertch, in the iron ore districts. Most of the works are situated about midway between the coal and iron deposits, and one is as far north as Kharkov, while three are on the Sea of Azov, at Taganrog and Marioupol.

The coal deposits of the Donetz basin contain a great variety of qualities from anthracite to bituminous. The anthracite is found in the southern and eastern parts, and the bituminous in the northern and western. The deposits were not systematically worked until 1840, and for many years the progress was slow. The construction of the railway to Azov in the early seventies increased the outlet for the coal, but it was not until the iron industry was founded that the exploitation of the coal was undertaken in earnest. At the present time the yearly output is about 21,000,000 tons.

Mr. Cunningham gives an outline of the practice at the eight plants so far built or building, two of which have been already superseded. The characteristic plants are at the Dome and Hollinger mines, and the others are at Vipond, Porcupine Crown, McIntyre, and Acme. At the Dome mine, Class A preponderates. When the mill started, the treatment was as follows: Stamping in water, primary amalgamation, fine grinding, secondary amalgamation, dewatering, agitation in cyanide solution, and Merrill filters. Later the practice was modified thus: Stamping, tube-milling, plate-amalgamation in water, cone-classification to three products, (*a*) slime, dewatered and agitated in cyanide solution and Merrill filters; (*b*) sand, leached; (*c*) concentrate, re-ground in tube-mill in closed circuit with classifier and amalgamation plate, classifier overflow to slime treatment. At the Hollinger, ore of Class B predominates. At the start the treatment was: Stamping in solution, fine grinding, concentration, concentrate amalgamated in solution and returned to table tailing, table tailing to agitators and Moore filters. Later: Stamping in solution, fine grinding and concentration, concentrate agitated in strong solution, washed, and impounded. A plant is now being built for agitation and complete counter-current decantation for one-third of the tailing from table-concentration. At the other plants in the district, the adoption of continuous decantation is a marked feature. The chief reason for the changes in practice is that more of Class B ore is now mined, and that the original experiments were made on Class A ore. The failure of straight amalgamation is clear. Amalgamation in conjunction with cyaniding is practised only at the Dome, where large bodies of Class A are still to be treated, and at Porcupine Crown, where only Class A has been found so far. At most of the mills, stamps are employed, but at the Vipond and McIntyre rolls and ball-mills are used, and the author is inclined to favour the latter plan.

The relative advantages of stamping in water with amalgamation and stamping in cyanide solution without amalgamation can be studied by a comparison of the Dome and Hollinger systems. The claims of the former method as used at the Dome are the better recovery of the coarse free gold, and the saving in the cost due to the smaller amount of the solution to be

Metallurgy at Porcupine.—The March *Bulletin* of the American Institute of Mining Engineers contains a paper analysing metallurgical practice at the gold mines at Porcupine, Ontario. Many alterations and variations have been made in methods at the plants in this district, and it is of interest to follow the reasons therefor. No oxidized ore is found at Porcupine, as the surface has been deeply planed by glacial action in recent geologic time. There are two classes of ore, with widely different characteristics. Class A consists of pure quartz with inclusions of schist. It is generally greatly fractured, and it breaks easily to grains of from 10 to 20-mesh. Further comminution in tube-mills is required to release the gold. It carries little pyrite. The gold is free and inclined to be coarse, but as it is often spongy it goes into solution readily. Class B is an iron-silicate schist, strongly laminated, carrying 4 to 5% of pyrite, and having a specific gravity of from 2·8 to 3. This ore is easily broken in milling, and it forms a comparatively large amount of non-crystalline slime. Owing to the high specific gravity of the slime it settles quickly. The gold in Class B is, in the author's opinion, free, but so finely divided that it will neither pan nor amalgamate. It appears to be disseminated through the rock and is not chiefly associated with the pyrite. As a rule these two classes of ore are found alternating in bands, generally with Class B predominating.

treated for the precipitation of the gold, and the smaller amount of precipitate to be handled. Also owing to the smaller amount of gold-solution being treated, less gold will be lost in the filter-washes. The assay-value of the Hollinger ore is three times that of the Dome ore, so that though there is a smaller percentage of amalgamable gold in the ore at the Hollinger than at the Dome, the actual amount of coarse free gold per ton is about the same at the two mines. Thus if amalgamation is necessary in order to assure the dissolution of coarse gold in cyanide solution, difficulty from this source would be expected at the Hollinger. This is, however, not the case, for all the coarse gold goes into solution in the closed circuit of the classifiers and tube-mills. This is proved by the fact that no coarse gold is ever seen on the concentrating tables below the closed circuit. The system of crushing in cyanide solution without amalgamation also has an advantage as regards the amount of solution treated for precipitation and the proportion of dissolved gold that may be lost. Though the gold content of the Hollinger ore is three times that of the Dome, the precipitation ratio is only about twice that at the Dome, and the mechanical loss of gold and cyanide only about one-half. No saving is proved in connection with dissolved losses or treatment cost in favour of crushing in water followed by amalgamation. On the other hand, there are additional items of cost: *(1)* cost of amalgamation, *(2)* cost of increased cyanide consumption due to waste solution precipitated and thrown away, and *(3)* in winter the cost of heating the water. The loss of gold left in waste solution must also be added to the cost. The author admits that unusually close study has been given by competent metallurgists to the treatment of Dome ore, and therefore he makes his criticism with due deference, stating that as the Dome ore is harder and more compact, the gold may be less spongy and therefore less amenable to cyaniding.

The Hollinger is the only mine to make a table concentrate. About 16% of the gold is recovered in this way, and the advantage to the general plan of extraction is considerable, for the ore, after the removal of the concentrate, requires much less careful treatment. The concentrate contains about $50 of gold per ton, and the cost of table treatment is about 5 cents per ton of ore or $1·25 per ton of concentrate. The removal of this concentrate greatly improves the action of the thickeners and filters, as thereby the material treated in these machines is of more even specific gravity, the cost of agitation is greatly reduced, and the clogging of the plant with heavy particles is obviated.

At the other mines, where no heavy sulphide is removed by concentration, much better results in connection with agitation are obtained with the Dorr agitator than with the Pachuca vat. In the latter, the heavy particles fill the conical bottom on the least provocation, even a few minutes interruption to the air-lift entailing this obstruction. This proportion of quick-settling material also militates against the success of the vacuum filter, and the tendency is nowadays, as already mentioned, to adopt the system of continuous counter-current decantation. The Hollinger is erecting this type of plant, and the Acme mill, under Hollinger control, is being built on this system. The fact that no colloidal matter is formed in milling, and that the particles are heavy and easily settled, conduces to the applicability of the ore to thickening, and probably the Porcupine district offers the best instance of application of this method of withdrawing gold solution from the exhausted ore.

CURRENT LITERATURE

[*Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.*]

The Ohio Copper Mine.—The *Mining Press* for March 6, F. Sommer Schmidt describes the caving system of mining at the Ohio Copper Company's mine, Utah.

Compressed Air.—At the March meeting of the Cornish Institute of Engineers, B. Angwin read a paper on 'Compressed Air: Its Use in Mines.'

Stoping Methods.—At the January meeting of the Canadian Society of Civil Engineers, C. A. Macaulay read a paper on the evolution of stoping methods during the last decade especially in connection with methods avoiding the use of timbers.

Electric Winding.—*Engineering* for March 10 and 17 contains a description, with many illustrations, of the new electric winding-plant of the East Rand Proprietary Mines.

Shaft-Sinking.—The *Colliery Guardian* for March 19 publishes an article by M. Gillieaux describing a Belgian system of lining shafts with specially-shaped segments of ferro-concrete.

Electricity applied to Mining.—At the February meeting of the Institution of Electrical Engineers, C. P. Sparks read a paper with this title, detailing the electrical power installation at the coal mines of the Powell-Duffryn company, South Wales.

Hammer-Drills.—The February *Bulletin* of the American Institute of Mining Engineers contains a paper by B. F. Tillson giving an account of the tests and applications of hammer-drills at the Franklin mines of the New Jersey Zinc Company.

Platinum Dredging. — In the *Mining Press* for February 27, R. S. Botsford describes the dredging operations for platinum in the Kytlim valley in the Ural mountains, Russia.

Callow's Flotation System. — The *Mining and Engineering World* for March 6 contains an article by H. W. Ingalls describing the Callow flotation plant at the Hunter Company's silver-lead mine, at Mullan, Idaho.

Estimation of Manganese.—In *Metallurgical and Chemical Engineering* for March, W. W. Clark describes a method for the determination of manganese in ferro-vanadium.

Manganese in Queensland. — The *Queensland Government Mining Journal* for January contains a paper by L. C. Ball, Assistant Government Geologist, describing manganese deposits at the Mount Miller mine.

Gold in Saskatchewan.—The *Bulletin* of the Canadian Mining Institute contains a paper by J. B. Tyrrell, describing the gold deposits in the North Saskatchewan river. These gravels have been worked in the Edmonton district for many years.

Zinc in the United States.—In the *Engineering and Mining Journal* for March 6, W. R. Ingalls gives an analysis of the figures for the production of zinc in the United States during 1914.

Zinc-Oxide Manufacture.—In the *Mining Press* for March 20, E. H. Leslie describes the manufacture of zinc oxide from carbonate ore, for use as a basis for paints, at the new works erected at Leadville.

Gold Gravels in Quebec.—The March *Bulletin* of the American Institute of Mining Engineers contains a paper by J. B. Tyrrell describing the alluvial gold deposits in Beauce county, Quebec.

Origin of Petroleum.—In the *Mining Journal* for March 13 and 20, R. C. Campbell-Johnston suggests a source of origin of the petroleum found in Western Canada. He is of opinion that the petroleum was formed by the distillation of the local coal-beds.

Argentine Minerals. — In the *Mining Press* for February 20, Arthur W. Jenks describes the mineral resources of Jujuy province, Argentine Republic.

Cracking Oil.—At the February meeting of the Institution of Petroleum Technologists, William A. Hall read a paper describing methods of 'cracking' petroleum with the object of producing petrol, and Vivian B. Lewes read a paper on the chemistry of the 'cracking' of heavy oils.

Secondary Enrichment.—*Economic Geology* for December contains a paper by G. S. Nishihara detailing investigations as to the reduction of acidity of descending waters caused by certain metallic and gangue minerals, and its bearing on the study of secondary enrichment.

NEW BOOKS

A Text-Book of Practical Assaying. By James Park. Cloth, octavo, 300 pages, illustrated, London: Charles Griffin & Co. Price 7s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

Though this book is now issued for the first time in this country, it has run through three editions in New Zealand, where it has been used as the authorized text-book for the New Zealand Government School of Mines. It covers a wide range of subjects in a concise form, from the assaying of gold ores to the analysis of milk. Bulk has been reduced by giving for each metal a standard method with all the necessary details of manipulation and omitting alternative methods. This system has of course its disadvantages, for we notice that Lunge's standard method for estimation of sulphur in pyrite is omitted. The results of compression are seen in other ways; for instance it would be advisable to have a more up-to-date method of drying the sample of ore than on the furnace. The tables given as an aid for calculating results in assaying gold and silver ores are remarkably compact. After giving the methods for determination of the metals in their ores, the author states the method for analysis of limestone, etc., and of portland cement. His chapter on rock analysis for igneous and metamorphic rocks is particularly useful. The classification of coals is good and helps the student to understand easily to what class his sample belongs. We are pleased with his pages on the determination of calorific value, which is justly full, and yet unnecessary details are omitted. The bomb calorimeter is given its due prominence. It is not often that the assayer is called upon to examine milk, but should he be so required he will find at the close of this book all the necessary details for determining the quality of this important article of food. The book closes with a full index. We feel we can congratulate both author and publisher on a useful and compact addition to the assayer's library.

A. J. C.

Assaying in Theory and Practice. By E. A. Wraight. Cloth, octavo, 330 pages, illustrated. London: Edward Arnold. Price 10s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The author states in the preface that this book gives the methods of assaying taught by him at the Royal School of Mines, during the last twelve years. During those years he has evidently taken pains to test a great many methods of treating ores, slags, etc., in order to determine their relative merits. The result is that he has produced a book that can be confidently recommended for use in assay-offices, as well as in colleges and schools.

In Part I the author has brought together a number of useful tables and other data, in excellent arrangement for reference, which should save much time in chemical laboratories, as well as prove valuable to students in colleges and schools. Tables are given of the latest determined atomic weights, melting points of metals, conversion factors, logarithms, also plans for laboratories of different sizes, etc. The table of 'Minerals and their Characteristics' is generally good, but it is difficult to see why such minerals as hubnerite, an ore of tungsten, malachite, a valuable copper ore, and monazite, the chief source of thoria, to mention a few, should be omitted, while such unimportant ones as vivianite and websterite are described.

In Part II great stress is rightly laid upon the importance of taking correctly representative samples of the ores and ore products to be assayed. The different methods in use are, by text and illustration, very clearly described. Part II also contains chapters on the examination of fluxes and reagents, gives illustrations of good furnaces, and describes fire, or dry, assays.

Part III is devoted to the wet assays of the ores of the common metals, and a few of the more rare. Where different methods in experienced hands give equally correct results they are given in detail, and the possible or probable sources of error indicated. The clearness of the working instructions for every process is a distinguishing feature throughout the book, and in most cases the changes that take place during the progress of the assay are given in chemical formulæ. While not agreeing with the author on all points, such for instance as that "the only accurate method" of estimating the amount of tungstic oxide in an ore is by precipitation by means of mercurous nitrate, the book can, as stated above, be confidently recommended for use in assay-offices and chemical laboratories where mineral chemistry is the chief practice.

BENEDICT KITTO.

Kaolin, China-Clay, and China-Stone. By J. Allen Howe. Octavo, paper covers, 280 pages, with many illustrations. Southampton: Ordnance Survey Office. Price 3s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This book is nominally a guide to the collection of kaolins and china-clays in the Jermyn Street Museum, and it is written by one of the curators, who is a distinguished authority on non-metallic minerals. But it is very much more than this. It is really the technical treatise for which we have been looking for many years. In the conduct of the Magazine, the reviewing of new books is the department least congenial to us, for so few are authoritative and of standard quality, too many of them being, we fear, the outcome of the authors' vanity or desire for publicity. All the greater is our pleasure, therefore, when a book of prime importance makes its appearance. Mr. Howe's book belongs to this class and fills a space on our shelves that has long been vacant. Though not a metalliferous mineral, china-clay is of considerable interest to our readers. We have often referred to the industry in Cornwall and Devon, and our pages have been adorned by an excellent article on the subject by Mr. J. H. Collins. At least two of the London houses of mining finance have invested in properties and in processes for treatment. China-clay is a valuable commodity and is always in demand, but there is so

little literature relating to its occurrence, uses, and methods of exploitation that few people are attracted by the commercial possibilities of a deposit.

Mr. Howe starts with a general account of the china-clay deposits of Cornwall, tracing the history of their discovery and development, and describing in detail the occurrences in the St. Austell, Bodmin Moor, and Dartmoor districts. He then proceeds to give an account of the methods for opening a deposit, extracting the clay, and preparing the marketable products. In the next section of the book, Mr. Howe enumerates the china-clay resources of other parts of the world, France, Saxony, Bavaria, Bohemia, Sweden, Spain, Italy, China, Japan, India, Australia, and the United States, giving geological and commercial descriptions of the chief occurrences and the methods of treatment. Another chapter is devoted to china-stone. Chapter 6 contains a mineralogical discussion of kaolinite and similar minerals. In Chapter 7 the author reviews the theories of the formation of kaolin, adopting the explanation provided by the reaction of carbonic acid contained in the emanations during the pneumatolytic phase. His treatment of the theories is so interesting that we give some space to it under Précis of Technology. Chapter 8 is devoted to a consideration of analyses and physical tests of various kaolins and china-stones. Then follow chapters containing statistics of production, etc., and lists of English china-clay pits and works. In an appendix, Allan B. Dick gives instructions relating to petrographic examinations, and another appendix contains an ample bibliography. The only cause of complaint in connection with this book is its issuance in paper covers.

E. W.

An Introduction to the Geology of New South Wales. By C. A. Süssmilch. Cloth, octavo, 270 pages, illustrated. Sydney: Angus & Robertson; London: Oxford University Press. Price 7s. 6d. net For sale at the Technical Bookshop of *The Mining Magazine*.

New South Wales is, in many ways, the most interesting mineral province of Australia. Champions of the other States may dispute our view, basing their argument on statistics of history and present production. But we argue that the literature officially published relating to the geology and mineral deposits creates much of the interest, both in the country itself and in England and other parts of the world. New South Wales has an excellent service in connection with its Geological Survey, and the professional papers relating to the copper, gold, tin, silver, lead, zinc, and coal deposits are of high quality. New South Wales includes within its borders many important mineral deposits. At Broken Hill are the lead-zinc-silver mines; in the northeast district alluvial tin is worked; the coal deposits around Newcastle and the central eastern district are highly productive; copper has been profitably mined at Cobar in the past; gold is recovered from alluvial and lode deposits. Though so many monographs have been issued by the Geological Survey relating to the mineral deposits, any general consecutive account of the geology of the State has been lacking for many years, as the report issued by the late C. S. Wilkinson in 1882 has long been out of print. The present volume is therefore particularly welcome. The author used to be lecturer in the department of geology and mining in the Sydney Technical College, and is now principal of the Newcastle Technical College. He has had the advantage of the assistance and help of many well-known geologists, such as Edgeworth David, Douglas Mawson, E. F. Pittman, E. C. Andrews, and J. E. Carne. It is probable that mining engineers will consider that the book contains too limited a reference to mineral deposits, and indeed this is our own feeling, but with the many available volumes on the economic geology of the State published by the Survey, we must condone these omissions and consider the book as a common link for those already published. It is interesting to note that Mr. Süssmilch issued a previous edition of his book, but that it did not circulate to any appreciable extent outside the State. The present edition embodies much extra material and illustrations.

Lead and Zinc Deposits of Northwestern Illinois. By G. H. Cox. Cloth, octavo, 120 pages, illustrated. Urbana, Illinois: The State Geological Survey. Price 8s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The deposits of the lead-zinc region at and around the point of meeting of the states Illinois, Wisconsin, and Iowa, have been worked for two centuries. Though the greater portion of the deposit is in Wisconsin, some of the largest individual mines are in Illinois. The author, G. H. Cox, is professor of geology in the Missouri School of Mines. His book supplements the bulletin prepared in 1906 for the United States Geological Survey by H. Foster Bain.

Gypsum in Canada: Its Occurrence, Exploitation, and Technology. By L. H. Cole. Octavo, paper covers, 270 pages, illustrated. Ottawa: Department of Mines. Price 8s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is one of the series of well-known monographs on Canadian minerals, prepared under the general direction of Dr. Eugene Haanel. Canada is the third largest producer of gypsum in the world, the United States and France being in the lead. Most of the output is sent to the United States for calcining. One half comes from Nova Scotia, and the rest from New Brunswick, Ontario, and Manitoba. Mr. Cole's book describes the deposits in the several provinces and the methods of mining and preparation. Chapters are devoted to the calcining process, the uses of gypsum in its raw and calcined state, the theories of the origin of gypsum deposits, statistics, etc. As a monograph it is equal in value to the others of the series dealing with graphite, asbestos, and pyrite.

The Copper-Smelting Industries of Canada. By Alfred W. G. Wilson. Octavo, paper covers, 190 pages, illustrated. Ottawa: Department of Mines. Price 8s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

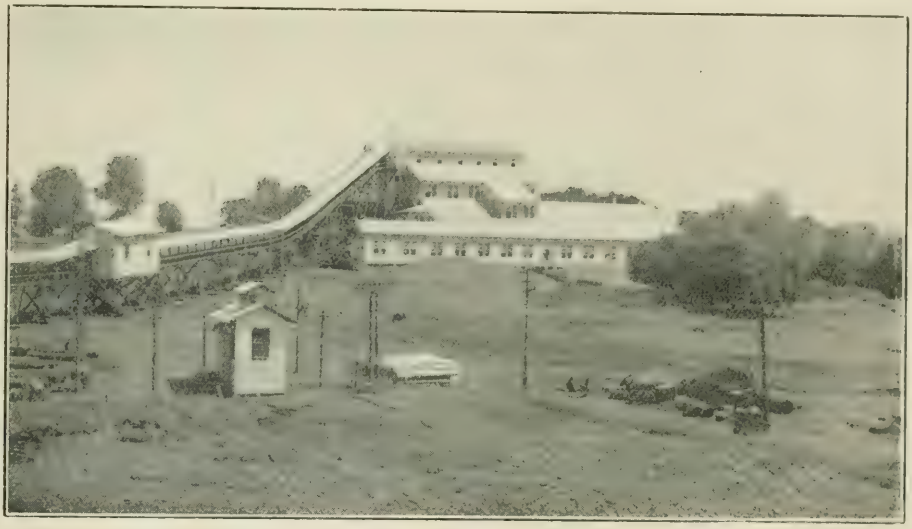
Lode-Mining in Yukon: An Investigation of Quartz Deposits in the Klondyke Division. By T. A. MacLean. Octavo, paper covers, 210 pages, illustrated. Ottawa: Department of Mines. Price 8s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

Aluminium Facts and Figures. Cloth, pocket size, 56 pages. London: The British Aluminium Company. Price 3s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The tables presented in this pocket-book are of great value to the engineer, more particularly the electrical engineer. They include figures relating to the sizes, shapes, weights, resistance, etc., of bars, rods, pipes, sheets, wires, etc., formulæ, constants, characteristics, and qualities of the metal. The pages are bound with strong staples, arranged in such a way that additions can be made at any time.

COMPANY REPORTS

Rio Tinto.—The report for 1914 of this company, owning the leading copper-producing mine in Spain, shows that the properties were idle during the first few weeks owing to the strike. The men resumed work in February, and operations continued on the normal scale until the outbreak of the war. The loss of the German market for copper and pyrite necessitated a substantial curtailment of the output. The various departments were kept going on the basis of three days work per week, and even then the whole of the mineral raised could not be sold. Since the end of the year, the demand from other than enemy countries has improved, and work has been increased to the basis of four days per week. The removal of overburden from the San Dionisio and South lodes has been continued. The underground development and the new deep-level



Stamp-Mill of the Plymouth Consolidated Gold Mines.

approaches to the orebodies are reported to be well in hand. The sales of copper as metal and in ore were 21,515 tons as compared with 36,320 tons in 1913, and the average price per ton was £59. 9s. as compared with £68. 5s. The divisible profit was £899,939 as compared with £1,673,372. Out of the profit £81,250 was paid on the 5% preference shares, and £656,250 on the ordinary shares, being at the rate of 35%. A year ago the ordinary shareholders received £1,406,250, the dividend being at the rate of 75 per cent.

Plymouth Consolidated Gold Mines.—This company was formed in July last to work the Plymouth Consolidated mines in Amador county, California, which had been reopened two years previously by the California Exploration Company, a company formed for the purpose by Bewick, Moreing & Co. We gave a full account of the mine and the system of development in our issue of February 1914. The directors' report now issued covers the period from the date of formation of the company to December 31 last, but the managers' report describes the operations at the mine throughout the year 1914. During the year, the Main shaft, which is vertical to the 1900-ft. level, was sunk on the incline to the 2150-ft. level. Cross-cuts were driven to intersect the old levels at 1850 ft. and 2000 ft., and plats and ore-bins have been excavated at the 1600, 1850, 2000, and 2150-ft. levels. Since the turn of the year, a cross-cut from the 2150-ft. level has cut the lode, and north and south drifts from the point of intersection have been extended for 90 ft., for which distance the lode averages 50s. per ton over a width of 80 in. The mill was completed at the end of July. During the five months August to December, 44,773 tons of ore was treated, yielding 5799 oz. gold by amalgamation and 3654 oz. in the concentrate, being a total of 9453 oz., which, together with 2869 oz. silver recovered, was worth £40,625. The yield per ton was 18s. 1d. The cost at the mine was £30,406, or 13s. 7d. per ton. After the allowance of £2379 for depreciation and the payment of London expenses £741, a net profit was left of £7011. Out of this, £4485 has been written off mine-development account and £2305 off the preliminary expenses account. A detailed description of the mill and the system of treatment was published in the *Mining and Scientific Press* for October 31 last.

Le Roi No. 2.—This company was formed in 1900 by the late Whitaker Wright to acquire the Josie, Annie, Poorman, and other claims at Rossland, British Columbia. After the collapse that followed shortly afterward, the company was taken in hand by Lord Ernest Hamilton and his friends, and Alexander Hill & Stewart were appointed managers. In spite of a heritage of over-capitalization and in spite of the great irregularity of the ore-shoots, large amounts of gold-copper ore have been extracted, and fairly satisfactory dividends paid. The Le Roi company, also promoted by Whitaker Wright, owned adjoining claims, and three years ago sold its property to the Consolidated Mining & Smelting Company of Canada, which works the War Eagle and Centre Star mines. An arrangement was made between the Consolidated and Le Roi No. 2 whereby the latter is able to develop the South Rodney orebody at depth from the 1650-ft. level of the Le Roi. The report for the year ended September 30 last shows that this development has given gratifying

results, and that an increased output may be expected. For the last two years no dividend has been distributed and money has been devoted to this extra development. During the year under review, 29,679 tons of ore was raised, of which 17,566 tons was shipping ore and 12,113 tons milling ore. The amount of ore actually shipped was 17,014 tons averaging 2·6% copper, 12 dwt. gold, and 1·76 oz. silver per ton. Of milling ore, 12,170 tons averaging 0·5% copper and 2·6 dwt. gold was treated, yielding 1322 tons of concentrate averaging 1% copper and 15 dwt. gold. After writing £15,341 off the development and depreciation accounts, the net profit was £6193, which was carried forward. At the meeting of shareholders, the chairman said that the improvement in the ore resources warranted the expectation of a dividend before long.

Van-Roi.—This company was formed in 1908, as a subsidiary of the Le Roi No. 2, for the purpose of working the Vancouver group of silver-lead-zinc properties in the Slocan district of British Columbia. Owing to the narrowness and irregularity of the lodes, the venture has not been a success, and on the outbreak of the war operations were suspended, as the selling-contracts were unfavourable. At the present time expenditure is being reduced to a minimum, the sole object being to keep the property in good condition. The report for the year ended September 30 shows that 16,025 tons of ore was raised and sent to the dressing-plant, averaging 2·69% lead, 6·64% zinc, and 13·85 oz. silver. The yield was 588 tons of lead concentrate averaging 54·7% lead, 11·15% zinc, and 192 oz. silver, together with 1096 tons of zinc concentrate averaging 39·4% zinc, 3% lead, and 54·9 oz. silver. The accounts show a revenue of £19,547 from the sale of concentrate, and a net loss for the year of £3835.

Mysore Gold.—The 31st annual report of the premier gold mining company in India, for the year 1914, shows that 304,375 short tons of ore was raised and milled for a yield by amalgamation of 195,485 oz. of bullion, and that 35,232 oz. of bullion was recovered by cyaniding 306,608 tons of tailing and slime. The total production was 230,717 oz. of bullion, equal to 202,394 oz. fine, worth £899,498. The working cost was £363,244, royalty £54,901, income tax £26,340, allowance for depreciation £15,288, and expenditure on capital account for erection of slime-plant and shaft-sinking £84,979. The shareholders received £350,750, being at the rate of 115%. As compared with the previous five years, the yield of gold has remained much the same, but the amount of ore treated has increased slightly. The drought during the months March to June did not interfere with the output, but development had to be restricted, so that the reserve has fallen. The interference with development was not, however, the sole reason for the decrease in the reserve, for this was partly caused by the unremunerative work done in the south part of Ribblesdale's section. As has been recorded in our pages from time to time, the developments north of the auxiliary shaft in Ribblesdale's section have disclosed large amounts of high-grade ore. The reserve was estimated on December 31 at 1,014,000 tons of a tenor not less than that now being milled, together with 250,000 tons of low-grade ore that will probably be mined and treated. The Mysore Government is extending the hydro-electric station on the Cauvery River by building a dam. In this way a reserve of power will be available in case the flow over the falls is seriously depleted during dry weather. The Kolar mines will thus in future be less likely to experience a shortage of electric power. Since the commencement of mining in 1884, the total yield of gold has been £16,181,309, extracted from 4,221,484 short tons of ore, and the amount distributed as dividend has been £7,765,094. The total amount of cash subscribed by shareholders and devoted to capital expenditure has been £905,000. This figure is higher than the nominal capital, £305,000, would indicate, but it must be remembered that capital has been subscribed on seven occasions since the formation of the company, always at a high premium. Original holders of Mysore shares have benefited more than is indicated by these figures, for in 1889, when the Champion Reef property was sold to a subsidiary, shareholders received a bonus of two shares in the new company for every five Mysore shares.

Nundydroog.—The report for 1914 of this company, operating one of the gold mines at Kolar, Mysore State, India, under John Taylor & Sons' management, shows that 89,950 tons of ore was raised and milled, the yield by amalgamation being 73,081 oz. of bullion, while 95,633 tons of tailing was treated by cyanide for a yield of 6843 ozs. of bullion, the total yield being worth £303,551. The working cost was £145,010, royalty £19,492, income tax £5407, and allowance for depreciation £35,824. The shareholders received £99,050, being at the rate of 35%. The developments during the year have been fairly favourable, in three different sections, and the reserve was increased from 150,650 tons to 164,800 tons. As compared with the previous year, the tonnage treated and the yield of gold were practically the same. Developments have not, however, sufficiently increased the reserve to make it possible to revert to the 100,000 ton capacity that ruled during the years 1909 to 1912, and the yield of gold and the profits have been consequently lower than during those years. The new slime-plant was started in October, but no clean-up was made before the end of the year under review.

Ooregum Gold.—This company owns one of the gold mines at Kolar in Mysore State, India, managed by John Taylor & Sons. Operations were commenced in 1888, and dividends have been paid continuously since 1891. The report for the year 1914 shows that 154,898 short tons of ore was raised, and that 86,569 oz. gold was extracted by amalgamation and cyanide, worth £367,081. The royalty was £21,659, working cost £177,007, allowance for depreciation of plant £15,000, taxes £1698, allocation to reserve fund £15,000, to insurance and contingency fund £1500, and donations £945. The distribution to shareholders was £138,270, being 45% on the preferred shares and 35% on the ordinary shares. This is the largest sum distributed to shareholders since 1893, when the dividends totalled £151,125. The development done during the year gave good results. In the southern section between Taylor's shaft and the Champion Reef boundary, the ore-shoot, originally discovered on the 46th level, has been proved on the 50th and 52nd levels, where it continues to yield ore of average grade. In the 52nd level in Oakley's section, the deepest level of the mine, the developments are most gratifying. In Bullen's section, where the northern part of the Taylor and Oakley shoots are being worked, the results on the 44th to 50th levels are satisfactory. The general results of development during the year are reflected in the increase of the ore reserve by 79,313 tons, the estimate at December 31 being 266,260 tons. In order to develop the mine at depth, it will be necessary to sink a new vertical shaft.

Barramia Mining & Exploration.— This company was formed in 1909 by John Taylor & Sons to acquire

a gold mine in Egypt between Edfu, near Assuan on the Nile, and the Red Sea. The mine was worked by the ancients, as recorded in an article by Alexander Cross in our issue of last December. The veins are narrow and occasionally carry unusually rich pockets. The report for the year 1914 shows that 5200 tons of ore was raised and that the yield of gold was worth £17,724. Of this gold, about £7500 was taken from 1600 lb. of 'specimen' ore contained in one of the characteristic pockets. The net profit for the year was £3423, out of which £2700 has been paid as 10% dividend on the preference shares. Nothing is paid on the £28,000 ordinary shares. A large amount of development has been done on the three lodes, Main, Taylor's, and New Caunter, but much of it has been without result. The Main lode continues to yield ore in the upper levels, though little is found in depth. The reserve is estimated at 12,000 tons. Experiments are still being conducted with a view to the treatment of the tailing and slime. The company has recently acquired a licence to examine the Semna, an old mine about 100 miles north, and prospecting and development work was started in November.

Sudan Gold Field.—This company was formed in 1904 by John Taylor & Sons to acquire prospecting licences in the Egyptian Sudan between the 20th and 22nd parallels of latitude. Eventually operations were centred on the Om Nabardi mine. This property is situated about 300 miles south of the Barramia, particulars of which are given in the preceding paragraph. It was necessary to reconstruct the company in 1908 and raise additional capital. The report for the year 1914 shows that 16,456 tons of ore was raised and treated, and 6170 tons of tailing cyanided, for a total yield of gold worth £49,898. After full allowance for depreciation, etc., the profit was £8987, out of which £6387 has been paid as dividend, being at the rate of 10%. This is the first dividend distributed, and this favourable result is due to the increase in the yield of £10,400 from practically the same amount of ore milled during 1913. During the year important discoveries have been made in Garland's lode. Here the lode showed a fold on the 300-ft. level, which being followed upward was found to extend to the 200-ft. level, after which the lode resumed its downward dip. Investigations are now being made with regard to the continuation of the lode, and exploratory work is being done with this object in view on the 400-ft. level. The ore reserve has been increased from 42,000 tons to 54,000 tons during the year.

Namaqua Copper.—This company was formed in 1887 to acquire copper mines at Concordia, in the west part of the Cape Province, South Africa, not far from the property of the Cape Copper Co. Dividends have been paid continuously, except during the years 1891 to 1894, 1908 and 1909. The report for the year 1914 shows that 28,907 tons averaging 5·86% copper was raised from the Tweefontein mine, 4286 tons averaging 6·56% copper from the Henderson mine, and 1828 tons averaging 5·16% copper from the Wheal Julia. The smelter treated 34,871 tons, of which 10,210 tons was briquetted fine, and produced 3808 tons of matte containing 2250 tons of copper. At the leaching plant, 113 tons of precipitate containing 78 tons of copper was recovered. The Elmore flotation plant treated 6648 tons of ore and tailing, of an unspecified assay-value, for a yield of 530 tons of concentrate averaging 24¾% copper. The development at the mines has not been encouraging. The ore reserve on December 31 was estimated at 80,875 tons averaging 6% copper, a fall of 26,017 tons during the year. The accounts show a net profit of £30,070, out of which £23,582 has been distributed as dividend, being at the rate of 12½ per cent.

East Rand Proprietary Mines.—The report of this company for the year 1914 shows that 1,979,881 tons of ore was raised, the proportion from the six sections not being given, and that after the rejection of 8·8% waste, 1,831,950 tons was sent to the mills. The total number of stamps at the four mills is 820, and there are 25 tube-mills. The average assay-value of the ore as sent to the mills was 6·8 dwt. gold per ton. The yield was 341,311 oz. by amalgamation and 255,135 oz. by cyanide, a total of 596,447 oz., worth £2,509,116, or 27s. 4d. per ton. The working cost was £1,772,929, or 19s. 4d. per ton, leaving a working profit of £736,167, or 8s. per ton. In addition, a profit of £73,363 was made from the treatment of accumulated slime. Out of the profit, £157,508 was allocated to capital expenditure on shafts and plant, £35,171 contributed to the Miner's Phthisis fund, £63,610 paid as debenture interest, £43,205 paid as profits tax, £17,567 paid as annuity for undermining rights, and £90,000 devoted to the redemption of debentures. The shareholders received £428,032, the dividend being at the rate of 17½%. This compares with 25% the year before, and with the 40% from the formation of the amalgamated company in 1908 to 1910. The development during the year amounted to 51,360 ft., and 1,597,801 tons of banket was disclosed, of which 1,070,979 tons was classed as profitable. At December 31 the ore reserve was calculated at 5,400,000 tons, averaging 6·6 dwt. over a width of 55 in. Water difficulties in the Driefontein and Angelo Deep sections have retarded shaft-sinking and development at depth. The developments in the Hercules and Angelo Deep sections have given poor results.

City & Suburban.—This company was formed in 1887 under Natal laws to acquire an outcrop mine in the central Rand. The technical control is with the Central Mining & Investment Corporation. Percy Cazalet is consulting engineer, and Charles Glyn is manager. Dividends have been paid continuously since 1888. During the years 1908, 1909, and 1910 the assay-value and the dividends were lower than the average, but conditions subsequently improved. The property as originally arranged terminated in an acute angle at the southern end, and as this would have been extremely inconvenient to mine, an additional 15 claims were purchased from the City Deep in 1913 so as to complete the rectangular shape in plan. The purchase price, £101,000, for these claims has been paid by instalments so as not to interfere with the dividends. The report for the year 1914 shows that 358,213 tons of ore was raised, and after the rejection of 9½% waste, 324,211 tons averaging 37s. 8d. per ton was sent to the mill. The yield of gold was 98,005 oz. by amalgamation and 42,050 oz. by cyanide, a total of 140,055 oz. worth £587,199, or 36s. 2d. per ton milled. The working cost was £338,648, or 20s. 10d. per ton, leaving a working profit of £248,550 or 15s. 4d. per ton. Out of the profit, £23,325 was paid as profits tax and £6260 under the Phthisis Act. The shareholders received £204,000, the dividend being at the rate of 15%. During the year 10,965 ft. of development was done, and the reserve was maintained, the figure on December 31 being 758,700 tons averaging 35s. 8d. The probable life of the mine is 9 years.

New Heriot.—This company was formed in 1887 under Natal laws to acquire a small property in the eastern part of the central Rand between Nourse and Jumpers. The management is in the hands of the

Central Mining & Investment Corporation. H. Stuart Martin is consulting engineer and Howard Warren manager. The report for the year 1914 shows that 184,032 tons of ore was raised, and after the rejection of 16% waste, 154,228 tons was sent to the mill. The yield of gold by amalgamation was 46,596 oz. and by cyanide 20,363 oz., a total of 66,959 oz. worth £281,765, or 36s. 6d. per ton milled. The working cost was £161,441 or 20s. 11d. per ton, leaving a working profit of £120,324 or 15s. 7d. per ton. Out of the profit, £12,073 was paid as profits tax and £2816 under the Miner's Phthisis Act. The shareholders received £74,750, the dividend being at the rate of 65%. The mine is nearing its end, and the estimate of its life is less than three years. The development done during the year was for this reason less than before. The reserve on December 31 was estimated at 588,315 tons averaging 8·1 dwt. per ton. The upper levels are being reopened and filling inserted, so that the ore in pillars may be reclaimed. Probably much ore will be found that was left behind as unprofitable in the old days. During 1914, the ore won by reclamation amounted to 31% of the output.

Nigel Gold.—This company was formed, under Natal laws, in 1887, to work a gold deposit near Heidelberg in the Transvaal. The ore is similar to that found on the Rand, and as the lodes dip northward the presumption is that they are connected with the basin now worked in the far east Rand. Dividends have been paid regularly since the start, except during the Boer war. The report for the year 1914 shows that 141,400 tons of ore was raised and treated, averaging 7¾ dwt. per ton. The yield was 25,400 oz. by amalgamation, 24,023 oz. by cyanide, and 1170 oz. from 8700 tons of accumulated sand, the total being 50,593 oz. worth £212,093. The profit for the year was £30,351, out of which £16,732 was paid as dividend, being at the rate of 7½%. The small rainfall and the consequent shortness of water-supply during the earlier part of the period under review, caused much anxiety and trouble at the power-plant and the mill. Since November the conditions in this respect have greatly improved, and at the time the report was published the reservoirs were overflowing. The development during the year amounted to 9866 ft., and 238,710 tons of banket was disclosed. As usual at this mine, a comparatively small proportion of the ore developed was worth working, 101,758 tons being returned as being over 6 dwt. and 136,952 tons below 6 dwt. At December 31, the ore reserve was calculated at 150,400 tons, and the accumulation of unprofitable banket was 878,200 tons.

Brakpan Mines.—This company was formed in 1903 to acquire gold-mining rights on part of the property owned by the Transvaal Coal Trust in the far east Rand. A large share-interest is held by the Consolidated Mines Selection Co. Milling was started in 1911, and the first dividend was paid for the year 1912. The report for the year 1914 shows that 705,755 tons of ore was raised, and after the rejection of 13% waste, 622,573 tons averaging 6·7 dwt. per ton was sent to the mill. The yield of gold by amalgamation was 124,838 oz. and by cyanide 79,123 oz., a total of 203,961 oz., worth £859,116, or 27s. 7d. per ton milled. The working cost was £575,660 or 18s. 6d. per ton, leaving a working profit of £283,456 or 9s. 1d. per ton. Out of this profit, £11,683 was allocated to development account, £25,872 was paid as taxes, and £225,000 was distributed as dividend, at the rate of 30%. The dividend for 1912 was 40% and for 1913 it was 32½%. The cost and yield for 1914 were not substantially different from those of 1913, and the smaller dividend is due chiefly to the extra amount of development done. As is well known, the percentage of profitable ore in the deep-level mines of the far east Rand is much lower than in the central Rand. During 1914 the percentage at the Brakpan was 40, as compared with 44 in 1913, but this slight fall is more than compensated by the increased width and higher grade. During the year, 24,389 ft. of development was done, 4739 ft. more than in 1913. Of the work done, 17,773 ft. was on the lode, 6945 ft. being in ore worth extracting, averaging 13·1 dwt. per ton over 41·5 in. The ore reserve was estimated on December 31 at 2,490,000 tons averaging 6·73 dwt. over a stoping width of 62 in., an increase of 248,000 tons during the year. The accumulation of unprofitable ore stands at 5,211,000, approximately representing one-half of the total banket developed. Some blocks of this may prove worth extracting eventually.

Springs Mines.—This company was formed in 1909 to acquire gold-mining rights on part of the property of the Transvaal Coal Trust in the far east Rand. The management is in the same hands as the Brakpan. Two vertical 7-compartment shafts have been sunk 4500 ft. apart, and the lode was intersected at depths of 3557 ft. and 3846 ft. in March and August of 1913 respectively. The report for 1914 shows that development had to be restricted owing to the unfavourable financial situation. As recorded in our March issue, the position has been relieved by the provision of the required additional funds. Work was suspended entirely on the North Shaft section during the latter part of the year, and in the South Shaft section development was slightly restricted. The work has been centred chiefly on the driving of haulage-ways, which being in the lode serve also as pilot headings for development purposes. The total development done was 13,411 ft., of which 8356 ft. has been sampled, averaging 21 dwt. over 19 in. For mining purposes an assumed stoping-width is taken at 52 in., and on this basis the reserve is estimated at 553,000 tons averaging 10·3 dwt. per ton. Of the ore developed 53% is classed as profitable.

West Rand Central.—This company was formed in 1895, as the White Rose Gold Mining Co., to acquire a small property at Krugersdorp in the far west Rand. The name was changed in 1897, when additional capital was subscribed. Milling started in 1898 with 20 stamps and a cyanide plant, and a slime plant was added in 1906. The capital is £100,000. The only dividends paid were 10% in 1904 and 7½% in 1905. The report for the year ended September 30 last shows that 26,554 tons of ore was raised and treated, for a yield of 10,674 oz. gold, worth £45,964. The net profit was £6413, but as the ore developed continues to be irregular in amount and content, no dividend was paid.

Dundee Coal.—This company was formed at Durban in 1899 to acquire a coal deposit in the north of Natal. Dividends have been paid from 1890 onward. On the exhaustion of the deposit, the Burnside mine was purchased, and in 1912 the mine of the St. George's Company was acquired by the issue of shares. During the past year an additional 50 acres adjoining the St. George's mine was acquired. The report for 1914 shows that 227,487 tons was raised from the Burnside mine and 151,854 tons from the St. George's, being a total of 379,351 tons. The sale of coal brought an income of £252,550. The working cost was £209,378, debenture interest £4984, and allowance for depreciation £15,502. The shareholders received £19,187, the dividend being at the rate of 12½%. In spite of strikes and the war, the output and sales were well maintained;

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Scientia non habet inimicum nisi ignorantem.

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STATISTICS.

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
July, 1914	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,006	676,221	2,872,406
March	727,167	26,768	753,935	3 202,514
April	717,225	26,855	744,080	3,160,651

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1914	154,202	9,471	11,979	175,652
February 28	157,673	9,508	12,266	179,447
March 31	162,815	9,619	13,390	185,824
April 30	165,005	9,625	14,150	188,780
May 31	165,433	9,619	14,284	189,336
June 30	166,248	9,442	13,256	188,946
July 31	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359

COST AND PROFIT ON THE RAND.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
January 1914	1,902,733	27 4	18 2	9 3	876,577
February	1,861,442	26 10	17 11	8 10	823,654
March	2,094,098	26 4	17 3	9 1	945,000
April	2,075,561	26 6	17 3	9 3	955,600
May	2,196,287	26 3	17 0	9 3	1,011,968
June	2,178,161	25 5	17 1	9 5	1,025,629
July	2,281,717	25 10	16 9	9 1	1,032,562
August	2,261,800	25 5	16 8	8 9	988,567
September	2,188,939	25 11	16 9	9 1	989,859
October	2,301,795	25 8	16 8	8 9	1,004,264
November	2,192,365	26 3	17 0	9 0	982,346
December	2,167,056	25 11	17 3	8 6	917,662
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

PRODUCTION OF GOLD IN WEST AFRICA.

Year 1912	Year 1913	Year 1914	Mar. 1915	Year 1915
£1,497,179	£1,634,700	£1,727,044	£153,770	£441,453

PRODUCTION OF GOLD IN RHODESIA.

Year 1912	Year 1913	Year 1914	Mar. 1915	Year 1915
£2,707,368	£2,903,267	£3,530,207	£299,686	£879,606

GOLD OUTPUT OF INDIA.

Year 1912	Year 1913	Year 1914	April. 1915	Year 1915
£2,265,094	£2,299,315	£2,340,259	£196,747	£788,322

PRODUCTION OF GOLD IN WESTERN AUSTRALIA.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
July, 1914	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435,164
September	1,535	103,577	105,112	446,485
October	2,028	99,366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900
March	1829	91,872	93,764	398,282
April	1017	101,592	102 609	435,853

OTHER AUSTRALIAN GOLD PRODUCTION.

	1913	1914	Apr. 1915	1915
	£	£	£	£
Victoria	1,847,400	1,740,300	109,300	444,300
Queensland	1,118,610	1,011,310	98,550*	228,170*

* March figures only.

EXPORTS OF COPPER FROM UNITED STATES
(Reported by United States Customs).

Month	Long Tons	Month	Long Tons
July, 1914	34,145	January, 1915	28,197
August	19,676	February	12,066
September	23,866	March	29,725
October	28,995		
November	20,170		
December	16,830		

NIGERIAN TIN PRODUCTION.
In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Year 1914 tons	Mar. 1915 tons	Year 1915 tons
2,532	5,032	4,832	418	1,193

PRODUCTION OF TIN IN FEDERATED MALAY STATES.
Estimated at 70% of concentrate shipped to smelters.

1911 tons	1912 tons	1913 tons	1914 tons	Mar. 1915 tons	1915 tons
43,967	48,250	50,128	49,042	3,653	11,828

SALE OF TIN CONCENTRATE AT REDRUTH TICKETINGS.

	Tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January 4, 1915	328¾	£28,353	£86 4 11
January 18	214½	£18,785	£87 13 8
February 1	215¾	£19,892	£96 13 8
February 15	227½	£21,801	£95 16 7
March 1	218½	£21,208	£97 3 5
March 15	205¾	£20,625	£100 7 3
March 29	224¾	£21,360	£95 0 10
April 12	201	£19,328	£96 3 2
April 26	209	£18,928	£90 11 4

IMPORTS OF TIN CONCENTRATE AT LIVERPOOL.
Reported by H. A. Watson & Co.

	April, 1915 tons	Total, 1915 tons
Bolivia	3,505	14,051
Nigeria	916	2,596
South Africa	200	664

REVIEW OF MINING

INTRODUCTORY.—Another month has gone and still the principal interest of mining men and in the mining markets is in the War. In thousands of ways its conduct is influencing the business of mining and the profession of mining engineering. As the month closed attention was focussed sharply upon the sinking of the *Lusitania*, an act of cold-blooded devilishness so terrible that public opinion had refused to believe it possible. The immediate question raised is whether the United States will, as a result of this culminating incident, be drawn into the conflict. While the principal value to the Allies of the assistance would be the moral effect of condemnation of the German methods of warfare by the world's greatest neutral, the great American republic could, none the less, give larger and more immediate aid in military and naval affairs than is generally appreciated. We speak elsewhere of the engineers who were lost and those rescued when the *Lusitania* went down. Here we are concerned with the effect on the market. In both New York and London the news was greeted with a fall of 10 to 15 points in stocks, followed by a slight recovery.

Our New York correspondent tells elsewhere of the stock boom that has begun in America. A well warranted depressed feeling is, however, everywhere prevalent in mining and industrial circles. The failure of the British Government to take courageous measures in connection with the annulment of German metal contracts, and in other ways to provide safeguards for home trades, creates distrust in business circles, as did also the refusal of the Treasury to sanction the issue of debentures in this country by the North and South companies at Broken Hill. Owing to this attitude of the Treasury, other base-metal mines now requiring additional funds may have to seek capital in America. The advance in price of copper, though not invariably regular, has been a notable feature of the month, and the quotations of shares in copper-mining companies have benefited. The dissolution of the Amalgamated Copper Company has been effected, and Anaconda and other stock distributed among shareholders. Zinc has advanced to £65, and the only free market is in the United States, though even here producers are in large measure sold up for months in advance and production is limited by inadequate smelting capacity. It is stated that the American smelters do not look favourably on the complex Australian zinc concentrate. In Germany reports of a scarcity of copper are becoming more insistent, though pig iron and steel production during March was reported at 946,015 and 1,098,273 tons respectively as compared with 803,623 and 946,015 during February. Reassuring figures regarding gold reserve and circulation have been given out by the Reichsbank, but *The Economist* voices general belief in refusing to consider this more than 'whistling to keep up the wind.' In Russia demand for metals continues heavy and prices high, and the splendid increase in industrial efficiency noted when vodka was banished is being maintained. In South America conditions are gradually righting themselves, though an undeveloped country

must necessarily progress more slowly, when outside capital is no longer available. It is pleasant to note at the end of the month that political differences between China and Japan, which threatened the peace of the world in a new quarter, have been composed. Under the new arrangements Japanese energy and resourcefulness are to have larger play in development of the latent resources of China.

TRANSVAAL.—The output of gold on the Rand during April was worth £3,046,579, and in outside districts £114,072, making a total for the Transvaal of £3,160,651. These figures are much the same as those for March. The number of native labourers employed at the gold mines on April 30 was 186,941, an increase of 1702 during the month, and comparing with 165,005 a year ago.

Development at the Robinson has been completed, and at December 31 the reserve stood at 364,700 tons averaging 45s. in gold per ton. This is enough to keep the mill going for seven months. Reclamation ore and low-grade ore from the Main Reef may keep operations going for another year or more, but the high-grade ore characterizing this mine is practically exhausted. The Robinson has been the most wonderful mine on the Rand and, for richness and tonnage combined, has never been equalled elsewhere. Since 1888, the gold recovered has been worth £19,521,691, extracted from 8,578,848 tons of ore, and £10,757,187 has been paid in dividends.

The output of the City Deep is still much below the figures quoted at the time of the flotation of the company. Only 140 of the 200 ordinary stamps and 4 of the 8 Nissen stamps were employed during 1914, and the ore milled was 42,000 tons per month instead of 65,000 tons. For so large a property the hoisting capacity has been much too small. All the work was put on No. 2 vertical shaft, sunk below the Meyer & Charlton. The continuation of this shaft on the incline following the dip has been delayed by the fact that part of the electric hoisting plant was ordered from Germany. No. 1 vertical shaft in the eastern section below the New Goch has recently been completed, as has also the vertical ventilation shaft near the Wolhuter boundary. If the shaft-sinking programme had been undertaken earlier, the tonnage hoisted might have been equal to the capacity of the treatment plant.

Another serious collapse of hanging wall is reported at the Ferreira Deep, in the section round No. 2 shaft, where the fall occurred in December. It is estimated that the output of ore will be reduced by one-half for several weeks.

The Village Deep report for 1914 shows a substantial improvement in the assay-value of the ore developed, for the average of the ore disclosed, 624,564 tons, was 8 dwt., as compared with 6·9 dwt., the average of the total reserve. Moreover the development was in profitable ore all the time, so that the reserve tonnage was maintained with 6000 ft. less of driving and sinking. Mr. H. Stuart Martin considers the outlook at this mine to be better than ever before.

The developments at the Bantjes, in the middle west Rand, have again been disappointing. During 1914 only 128,000 tons of ore, about one-third of the amount required at the mill, was developed. Like so many other mines in the neighbourhood, the results have been generally poor. Though it is an outcrop mine, and started milling in 1888, no dividend was declared until 1913. The ground is much broken by dikes and faults.

The Meyer & Charlton continues to develop in a highly gratifying manner, and the mine is quite the brightest spot in the central Rand at present. The assay-value of the reserve has risen 2 dwt. per ton during 1914 and stands now at nearly 14 dwt. Half of the reserve is in the Main Reef Leader, where the ore contains an ounce of gold per ton over a calculated stoping-width of 46 inches.

Rumours have been afloat for several weeks to the effect that the Jupiter mine is to be reopened. An official statement has subsequently confirmed the rumours. It is proposed to work the eastern part of the property and to hoist 20,000 to 25,000 tons per month, equal to about half the capacity of the metallurgical plant. Milling commenced in 1908, but was suspended in 1913, owing to the grade of ore developed becoming lower, and it being impossible to raise additional capital for the purpose of increasing the scale of operations.

The capacity of the mill of the Government Gold Mining Areas in the far east Rand is to be doubled by the erection of 100 additional stamps. Mr. J. G. Lawn, in making this recommendation, writes more cheerfully with regard to developments and future prospects than might have been expected, judging by the results achieved so far. Milling was started in the middle of October, and from then to the end of the year 97,700 tons yielded gold worth £80,965, being an extraction of only 16s. 7d. per ton. By April, matters had improved and £54,625 was obtained from 46,200 tons, being a yield of 23s. 7d. per ton. The working cost has decreased during the same time from 21s. 7d. to 19s. per ton. The ore reserve is estimated at 2,451,581 tons averaging 5·8 dwt. per ton over a stoping width of 60 in. The whole of the working capital, £1,400,000, has been spent, and also £250,000 advanced on loan by the parent company, the Johannesburg Consolidated. Further funds amounting to £200,000 will be required for the erection of the additional plant.

The developments at Van Ryn Deep continue excellent, and the reserve is estimated at 1,692,000 milling tons calculated to yield 36s. per ton. The working cost per ton has been decreased by 3s. during 1914, standing now at about 16s. 6d. By the use of the Butters filter, the gold left in the slime-residue has been reduced to less than 8d. per ton.

The Geduld paid its first dividend as a result of the work done during 1914, the sum of £46,125 being distributed on a capital of £922,500. The company was formed just before the Boer war, and shaft-sinking commenced in 1904. The enormous flow of water postponed regular milling until the beginning of 1910. The present metallurgical plant has a capacity of 24,000 tons per month, which is small for so extensive a property. Labour scarcity and financial conditions have postponed the carrying-out of Mr. McEwan Cameron's plan for increasing the scale of development, but the position has greatly improved of late, and in all probability proposals for expansion will be made public before long.

The dividend paid by the Central Mining and Investment Corporation for 1914 is at the rate of only 2½%, £127,500 being distributed on a capital of £5,100,000. Owing to the depreciation of share quotations and other interests, it has been necessary to write-off £663,073. Arrangements have been made for the cancelling of the participating interest of certain directors in the profits of the company. Some of these directors have relinquished the right entirely, and the others are to be bought out by the payment of £19,000.

Developments at the Zaaiplaats tin mine have been disappointing lately, especially in No. 13 section, which contains the principal 'pipe,' and the output during April fell considerably. The ore is rich at this group of deposits, but the distribution of the cassiterite is erratic, so that the venture has always been highly speculative. The best year was 1911-12, when 1470 tons of tin concentrate was extracted from 27,000 tons of ore. The concentrate is sold to the Straits Trading Company, and treated at the smelter at Singapore.

RHODESIA. — The output of gold during March was worth £299,686, as compared with £286,789 in February, and £273,266 in March a year ago. The figures have not improved since October last, when the record of £337,241 was registered. The individual reports from

the chief mines for March generally show increases over February, due probably to the longer month.

The directors of the Globe & Phœnix have omitted from their yearly report the figures for the ore raised. Nor do they issue any statement by their consulting engineer or their manager. The reason for these omissions is to be found in the fact that litigation is pending with the Amalgamated Properties of Rhodesia in respect of the extent of the rights of the owners of the John Bull claims. Such information as is given in the directors' report indicates that the developments in depth are not altogether satisfactory. The orebody appears to be divided into small shoots on the 20th level. On the 21st level the results of work on only one small shoot are quoted, and much is made of a small amount of rich ore in a winze below this level. Developments on the levels immediately above and below the dike have added to the ore reserve, which on December 31 stood at 194,400 tons averaging 29·5 dwt. per ton.

The Thistle-Etna, a Rhodesian company controlled by the Gold Fields, has unexpectedly paid a dividend, at the rate of 20%, but the prospects for the future are gloomy. The mines worked by this company have been generally disappointing, and the Etna is the only one that has been anything like a regular producer. Even here the reserves were exhausted temporarily early in 1912, and milling had to be suspended for the greater part of the year while development was pushed. In declaring this dividend, the directors appreciated the fact that most of the profit had not been earned during the year, but consisted of an accumulation of profit, and did not claim their share of the year's profits as provided by the articles of association.

WEST AFRICA.—The Bauchi company has issued another report from Mr. A. R. Canning, which is in much more hopeful vein than that published three months ago. The outputs in February and March were 22 tons and 30 tons respectively, a substantial improvement over the average of 18 tons at first expected. Mr. Canning foreshadows an increase to 40 or 45 tons at an early date. As the price of tin has advanced and the railway rate reduced, it has been possible to charge the cost of boring to revenue instead of to capital expenditure.

INDIA.—The Hutti Nizam's company, working the gold mine in Hyderabad, announces the discovery of an ore-shoot at the 2460-ft. level, the deepest yet driven, and that the ore assays 1 oz. per ton over 2 ft. The results of development during the last three years have not been encouraging. The deepest part to yield profitable ore hitherto was on the 1940-ft. level. Below this point, successive levels gave disappointing results, but a year ago the 2240-ft. level revived the hopes of shareholders. The present discovery will still further improve the prospects of the company.

The Anantapur Gold Field company is about to undertake extensive development on the Ramagiri block near the No. 1 South shaft, with the object of testing the lode below water-level. At the Jibutil mine, in the same district, the lode on the 1000-ft. level north of the South shaft is 10 ft. wide and averages 7 dwt. per ton.

AUSTRALASIA.—Details are published with regard to the amalgamation of smelting interests by the Proprietary, North, and South companies at Broken Hill. A new company is to be formed, with a capital of £750,000, of which £600,000 will be subscribed in equal portions by the three companies, for the purpose of acquiring the Port Pirie smelting works belonging to the Proprietary company, the purchase price being £450,000 in cash. It will be seen that the new company is thus provided at once with £150,000 working capital, with reserve shares, representing a similar amount, to be issued whenever opera-

tions are expanded. The Proprietary obtains by this deal £250,000 cash, which will presumably be devoted to the iron and steel enterprise. The funds required by the North and South companies for the purchase of their shares will be raised by the issue of debentures. Owing to the opposition of the Treasury these debentures cannot be offered in this country and will be subscribed entirely in Australia.

The Commonwealth Government is taking steps to legalize the annulment of metal contracts with German firms, and a bill has been introduced into the Federal Parliament to give effect to this step. The law if passed will only affect the companies registered in Australia. The English companies, such as the Sulphide and Zinc Corporations, are hoping, apparently in vain, for the English Government to tackle the matter in the same way.

The results at the Waihi gold mine in New Zealand during 1914 have been much the same as during the previous three years, 183,405 tons of ore yielding gold and silver worth £332,165 having been produced, while £99,181 was distributed as profit, being 4s. per share, or 20%. The output of precious metal was about one-third of that for 1909, and the dividend was 14s. per share less. Development on the 11th level has resulted in the intersection of the chief lodes that were highly profitable on the 9th and upper levels, notably the Martha, Empire, and Dreadnought, and in some parts of these profitable ore has been found. The Martha lode is nearly 60 ft. wide on this level but only 9 ft. is worth working.

The Waihi Grand Junction, which works extensions of some of the lodes of the Waihi, reports that exploration on the 7th level has given generally satisfactory results in the Empire lode and in the western drift on the Royal lode, but in other parts the ore developed is low-grade and patchy. The reserve on December 31 was estimated at 173,000 tons, a fall of 2100 tons during the year; but on the other hand the amount of ore raised during 1914 was 17,337 tons more than during 1913. The ore treated was 115,720 tons, and the yield £231,546. The dividend was £57,656, or 15%, comparing with 10% for 1913 and 5% for 1912. The percentage of recovery continues to advance, and now stands at 92% for the gold and 79% for the silver. The manager, Mr. W. F. Grace, has introduced many improvements in mining methods and metallurgical practice since he took charge five years ago.

The Standard Consolidated Tin Mines has been forced into liquidation owing to the Treasury refusing leave to issue new capital. This company belongs to the Lempriere group, which controls the British Broken Hill and Cornwall Tailings companies. The property is a lode mine, and is situated northwest of Charters Towers.

Mr. Loftus Hills, of the Tasmanian Geological Survey, has visited Broken Hill with the object of investigating differential flotation and its application to the complex lead-zinc ores of the Mount Read and Rosebery districts. In these ores, the galena and blende are so finely mixed that jigs and tables are ineffective. He finds that if the ores are crushed to minus 150-mesh, a separation can be effected by means of differential flotation.

CANADA.—Our Toronto correspondent presents details as to development of the gold and silver mines of Eastern Canada, where a cheerful optimism seems fully warranted by the condition of the properties. The Nipissing and Hollinger mines stand out as making particularly good showings. Seneca-Superior is being rewarded for a brave venture by finding additional ore at depth. The Dome, too, it is reported, has ore on the 6th level worth $18 per ton, though how extensive it may be is not yet revealed. There has been a change of control at the Dome, or rather a reversion to former conditions. Mr. Ambrose Monell and his associates have resigned from the

board, and the veteran J. R. De Lamar, always a heavy stock-holder, has again taken the direction of the property. Whether this will make any change in the technical direction is as yet not settled. The Canadian Mining Corporation reports that the electric pumps have been placed in position for the purpose of draining Cobalt lake, and that electric power is now being supplied. The emptying of the lake is expected to occupy most of the summer.

UNITED STATES.—Interest in America is centred for the moment in the revival of share speculation in Wall Street, which began late in April. There were several 'million share' days, after which the trade settled down somewhat, but is still in volume far beyond that of recent months. A welcome feature is that it seems to reflect genuine buying, and is not wholly speculation. The United States is really in an excellent situation, even though new business is slow in developing. The excess of exports over imports for February amounted to $298,727,800, the largest monthly excess on record for that country. The United States Steel Corporation report for the quarter showed profits of $12,458,000, against $10,933,000 for the quarter that ended with December, and $17,994,000 for the first quarter of 1914. Even more significant was the fact that February and March earnings each showed a most substantial advance over those for preceding months. The size of the Steel Corporation, the variety of its products, and the fact that it has not gone in for war contracts, make it an excellent barometer, and the figures indicate a real return of industrial activity. The new wave of prosperity has spread at least as far west as Denver where, following the revival at Cripple Creek resulting from the finding of bonanza ore in the Cresson Cons., comes the announcement that the Golden Cycle properties have been sold for $4,500,000, with which comfortable sum in cash Mr. John T. Milliken retires from the great business he has built up. The mine goes to the Vindicator company, thereby stopping disastrous litigation, while the mill and coal properties go to a syndicate headed by A. E. Carlton, Spencer Penrose, and Sherwood Aldrich. At the Commonwealth mine in Arizona about 2,000,000 gal. of water, equivalent to 26 tons per ton of ore, is being pumped and so far only low-grade ore has been found. However, heavy pumping was anticipated and preparations made. Natomas is doing better than was anticipated at the time of the reorganization, and the full issue of notes provided will not be needed. In the meantime the company engineers have made interesting advances in technology, of which we shall speak at another time. Flotation litigation is still active, and in April there were important hearings before the Federal court at Wilmington, Delaware, involving the validity of Minerals Separation patents. The defendant in this instance was the Miami Copper Co., which is using the Callow apparatus with excellent results.

Mr. Philip Argall reports that the dumps at Stratton's Independence are nearly exhausted, and that the mine is not likely to yield the company a profit much longer. It is proposed, therefore, to sell the property for £60,000 cash to the adjoining Portland Gold Mining Company. The denomination of the shares is to be reduced from 2s. 6d. to 1s. 3d., so that the value of the total shares, 1,000,000, will approximately represent the cash resources. It is intended to acquire another property, and Mr. Argall's recommendations in this connection will be issued shortly. These matters are to be decided at a company meeting to be held May 17, Mr. Argall having come to London to advise with the directors in the matter.

MEXICO.—Cables to London report the mills at both El Oro and Pachuca mainly closed for lack of supplies. The mines are not producing, though development is being continued in most of them. At the Esperanza

a discovery of ore assaying 1 oz. gold and 24 oz. silver in the Descubridora vein is reported, but its importance cannot be evaluated with the data at hand. Transportation from Pachuca to the City of Mexico is by motor, and from there to Vera Cruz railway transportation has been so uncertain as to prevent shipments of bullion, though it is now thought that these can be got through. Abundant supplies are available at Vera Cruz, but until these can be sent to the mines production will be small.

RUSSIA.—Russian gold producers met in convention at Petrograd in February, and petitioned the Government for various changes believed to be essential to stimulation of gold production in the Empire. Aside from numerous modifications of mining regulations, abolishment of the tariff on gold-mining machines —particularly dredges—was asked, and a vigorous campaign of railway building was urged. In support of the first proposal it was shown that the Putilov company, the only local builder, is fully occupied with government contracts, and that the tariff merely operated to raise prices to local gold miners, necessarily discouraging introduction of dredges. As to railway building, there can be no doubt that the ministers of the Czar already recognize the supreme importance to the country of better means of transportation, and that new lines will be laid as rapidly as they can be financed. Unfortunately, placer mines afford a poor basis for support of railways, but there is ample field for an extensive campaign of building in districts where both mining and agriculture may be served. We note elsewhere the seasonal return of engineers to the rapidly developing mines in the Russian Empire.

The shares of the Irtysh Corporation were placed on the market this month at £2. Concurrently the board issued a circular bringing the information up to date. The additional bore-holes at the Ridder mine have increased the ore reserve. The old workings have been sampled, and the levels and shafts re-timbered. A new shaft is being sunk at the north end of the open-cut. During the reopening of the old workings, 100,000 tons of oxidized ore was discovered, assaying 18 dwt. gold per ton. The plans for the railway to connect the Ridder with the Irtysh river have been completed. The earthwork should be finished by the end of the current year, and the line in operation by the middle of 1916. A zinc smelter is being constructed and the first unit of two blocks is to be in commission by the end of the year. Plans call for other blocks to be erected rapidly. The plant is modern in every particular, using producer gas, hydraulic pressed retorts, and similar equipment.

SOUTH AMERICA.—In this issue we publish an article describing the construction of the leaching-plant at Chuquicamata, Chile, written by Mr. Lincoln C. Rogers. It was expected that the property would be in operation on March 1, but delay in the receipt of machinery due to disturbance of traffic made it necessary to postpone the opening of the plant until the present month.

Things generally have taken a slight turn for the better in the nitrate fields of Chile, and prices have risen. Since, however, shipping is still irregular and bottoms scarce, the producers have not been able to take full advantage of this change. The increase in the price of copper is also being felt, and gradually conditions are becoming normal in this enterprising country of the West Coast.

The Minerals Separation plant at the Braden copper mine is working at full capacity. During March the jigs and tables treated 80,304 tons of ore averaging 2·01% copper, and yielding 7043 tons of concentrate averaging 15·66% copper. The flotation plant treated 78,698 tons, and extracted 1261 tons of concentrate averaging 18·82% copper.

MALAY. — The Chenderiang company, operating in Perak, reports that the bucket-

dredge built by William Simons & Co. has started work, and that it has given satisfaction in the trial run of five days. The Kamunting company, belonging to the same group as the Chenderiang, reports that the dredge commenced operations toward the end of March. The Renong company reports that No. 1 dredge is once more at work, and that No. 2 dredge is still under repair.

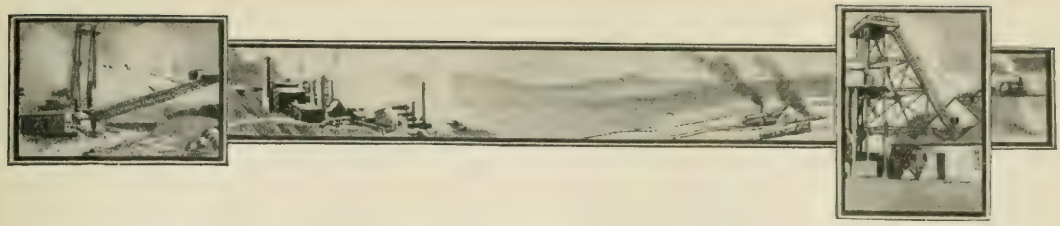
The Tronoh, which has been for some years the biggest producer of tin in the world, was hard hit during 1914, partly by the fall in the price of the metal and partly by the decreased yield per cubic yard, and instead of making a handsome profit is obliged to record a loss on working. The yield was 1539 tons of black tin, extracted from 442,394 cubic yards of gravel, being a recovery of $7\frac{3}{4}$ lb. per yard. The respective figures for 1913 were 2187 tons, 577,930 yd., and $8\frac{1}{2}$ lb., and those for 1912 were 2776 tons, 496,495 yd., and $12\frac{1}{2}$ lb. The average price obtained by the sale of the black tin during 1914 was £92, as compared with £123 in 1913 and £126 in 1912, and the total revenue was £139,015 as compared with £268,000 in 1913 and £349,334 in 1912. For 1912 the dividend was at the rate of 75% on a capital of £160,000 and for 1913 it was $37\frac{1}{2}$%. A loss of £20,109 for 1914 reflects the adverse conditions in the Malay States during the latter half of the year.

KOREA.—The Oriental Consolidated, the pioneer Anglo-American gold-mining enterprise of the Far East, presents an excellent report. For the year to the end of June 30 next it is announced that the total of dividends will amount to 8s. as compared with 6s. previously. The output for February was valued at $125,000. In December 28,682 tons was treated, yielding bullion to a value of $148,216. While less ore has been crushed recently than in earlier years, gross receipts have been larger owing to closer saving, and at the same time costs have been reduced, in large part due to introduction of hydro-electric power. The Seoul Mining Co. likewise continues to report good returns. In February, 6480 tons crushed yielded $62,100, on which the net earnings were $37,100. Both companies control large areas far from adequately explored as yet. For the Seoul company Dr. Malcolm Maclaren is now studying the further economic possibilities of the great Collbran contact, following the careful mapping compiled by Mr. D. F. Higgins about a year ago.

PHILIPPINE ISLANDS.—Mining at Benguet is more active. Mr. C. M. Eye is driving a new drainage adit below the old workings of the Benguet Consolidated and also erecting a modern cyanide mill and hydro-electric power plant.

SPAIN.—Most of the copper and sulphur mines in the south of Spain were adversely affected by the stoppage of shipments to Germany, where the sulphuric acid manufacturers are large purchasers of Spanish pyrite. The Tharsis company is, however, an exception and has suffered little inconvenience, owing to the fact that its principal markets are within the United Kingdom. The firm of Charles Tennant, Sons, & Co., of Glasgow, is one of the chief customers.

CORNWALL.—Many of the mines are at present suffering from an acute scarcity of labour, owing to so many of the best miners having enlisted. The formation of Pioneers' Battalions of the Duke of Cornwall's Light Infantry has proved a great incentive to recruiting. A large proportion of the men still working at the mines have other interests, notably the cultivation of the proverbial cabbage-patch. They have a habit of missing shifts, thereby adding to the anxiety of the managers. The advance in the price of materials, especially coal, has increased the working cost. Fortunately the recent steadiness in the price of tin has helped the companies, but the labour scarcity makes the outlook uncertain.



EDITORIAL

MEMBERS of the chemical fraternity in London might test the neutrality of American drinks by means of the usual litmus or phenolphthalein.

EVERY year, when the iron grip of winter relaxes, there begins the seasonal migration of mining engineers to the northern lands. In the United States, engineers leave San Francisco and Seattle for Alaska and the Yukon, while those who have their headquarters in London depart for Petrograd, the Urals, the Altai, and Nicolaievsk. Among those who have gone to Russia during the last few days are Messrs. Leslie Urquhart, J. B. P. Webster, R. Gilman Brown, Deane P. Mitchell, W. T. Madge, and Walter G. Perkins.

THE BESTOWAL of honorary membership of the Institution of Civil Engineers on Colonel George Washington Goethals affords a proof that his services in connection with the construction of the Panama Canal are fully appreciated by his fellow engineers in this country. With an original Dutch patronymic and a prenomen commemorating the founder of the great republic, and with a training at West Point Military Academy, Colonel Goethals was endowed with every advantage of heredity and education. From 1880 to 1907 he was in control of many engineering works in connection with river and harbour improvements. His appointment in the latter year as chief engineer and director of operations in connection with the Panama Canal was recognized as being particularly appropriate, and it has been justified by the results. His military training qualified him for the duties of administrator, so that he has been an efficient governor as well as a successful engineer. Like other large-minded men, he has passed much of the public praise to those serving under him, and has generously acknowledged the engineering skill of his staff.

OUR plea for military training expressed in the editorial last month has received the commendation of many who are better able than we are to carry the scheme to fruition. Sir Robert Baden-Powell writes to tell us that he has recently inaugurated a 'Prospector's Badge,' to be awarded to the boy scouts who possess an elementary knowledge of minerals, and who exhibit a natural bent for prospector's work. The combination of military training with the ability to search for minerals forms the ideal outfit for the pioneers of empire. The recognition of the value of the work of the prospector comes appropriately from the nephew of Warington Smyth.

MINING, as well as other industries, lost heavily when the *Lusitania* was torpedoed. Among those lost were F. S. Pearson, C. T. Brodrick, and R. R. Freeman, while Mr. Scott Turner, bruised and with a crushed shoulder, eventually made his way to the land, and Mr. Clinton P. Bernard, by virtue of being an excellent swimmer, escaped unhurt. Pearson's interests in mines, railways, traction lines, and power projects

extended over South as well as North America. Brodrick was geologist for the Russo-Asiatic Corporation, and Freeman had just become his assistant. Both were young Americans of the best type, graduates of Harvard, hard-working, enthusiastic, and of marked ability. Brodrick went to Russia in 1910 to assist Mr. S. H. Ball at Atbasar, and was in 1911 assistant to Mr. H. W. Turner at Kyshtim. Later he examined the Ridder alone, and his judgment there won the sincere respect of Mr. R. Gilman Brown and his associates. Freeman's experience had been with the Cleveland Cliffs Iron Company. Who gains by the death of such men?

ELSEWHERE in this issue is given an outline of Mr. C. H. Benedict's process for leaching copper tailing by means of ammonia, and the information presented is sufficient to indicate the difference between this process and others based on the same principle proposed or tried in earlier days. Mr. Benedict shows that much of the loss of ammonia troubling previous experimenters is not due to evaporation but to adsorption. Since the last work was done with ammoniacal solutions, physical chemistry has made great strides, and the retention of dissolved chemicals on the surface of solids has been recognized and elucidated. This new knowledge greatly helped Mr. Benedict in devising a process that involves little loss of ammonia. An equally important matter solved by him is in connection with the recovery of the copper from the solutions coming from the leaching vats, and the resulting simplification of the precipitation plant. By scientific regulation of the four successive solutions sent through the tailing, he has made it possible that all the extracted copper shall be contained in one-fifth of the total bulk of circulating solution. The size and first cost of Mr. Benedict's precipitation plant are, therefore, much lower than anything hitherto tried.

Crown Mines.

The yield of gold per ton at the Crown Mines has been falling recently, in a way that is naturally disconcerting to shareholders. The first notable announcement made by the company related to the December results, when the extraction was only 24s. 5d. per ton, as compared with the estimated average of 28s. 5d. in the ore reserves at the end of 1913. Succeeding months have given similar disappointing yields, and the directors have issued statements to the effect that a thorough investigation is being made. In the meantime, the report for the year 1914 has been published, and this throws some light on the position. The development during the year has given disappointing results, for the profitable tonnage opened was only 1,742,700 tons, as compared with 2,558,668 tons hoisted during the year. The amount of unprofitable ore developed was 534,070 tons, a much larger proportion than has been characteristic of this property hitherto. The South Reef in particular has been disappointing, for 36% of the development has been in unprofitable ground. The report unfortunately does not give the assay-value of the ore developed. The total reserve on December 31, 1914, was estimated at 10,022,000 tons averaging 6 dwt. per ton, as compared with 10,449,000 tons averaging 6·82 dwt. the year before. From the ore raised during the year, 2,287,600 tons was sent to the mill, after the rejection of 10% waste, and gold worth £2,975,687 was extracted, being 26s. 11d. per ton milled. During the previous year £3,248,131 was extracted from 2,195,000 tons milled, or 2,483,622 tons raised, being 29s. 7d. per ton milled. It will be seen that the yield per ton milled was 2s. 8d. less in 1914 than 1913. It is clear that the re-sampling at the end of 1914 has disclosed a necessity for writing-down the average assay-value of the reserves, for the difference between the figures for the content at the end of 1913 and 1914 could

not be explained by any considerable drop in the assay-value of the ore developed. No doubt the chairman will explain the matter when he addresses the shareholders next month. Until a complete statement is published, we can only surmise from the past history of the property and the conditions at the time of the consolidation in 1909, that the richer portions of the deposit in the eastern part belonging to the older mines entering into the amalgamation have been gradually exhausted, that more ore has now to be drawn from the western portions which were known to be of lower grade, and that developments at depth are, for the time being at any rate, unsatisfactory. Mr. R. C. Warriner expresses the opinion that the large variation in content exhibited by recent developments is abnormal, and we know that on general principles Mr. H. F. Marriott does not believe in the theory of permanent impoverishment in depth on the Rand. We may hope that this more cheerful view will be sustained by events, but while waiting for further information from headquarters, we must leave it at that.

Technology of Oil-Land Valuation.

Valuation of oil lands is one of the most difficult problems that must be faced by the consulting engineer. The vagaries of ore-shoots in metal mines are fully equalled if not excelled by the irregular distribution of productive and unproductive areas in oilfields. In addition it is entirely impossible to do anything comparable to exposing and sampling the orebody. Speaking in general terms, oil once 'exposed' must be marketed, since a well drilled-in but not allowed to flow gives little information as to the amount of oil in the land, and the storage of all the oil, if drawn from the wells to determine its quantity and grade, would impose so heavy an investment and so large an interest charge as to eat up all possible profit. Among mineral products entering the world's markets, furthermore, there are few exposed to more sudden and drastic changes in market price. Add to this the fact that petroleum production, to become a sound business requires large capital, and it will be seen that the petroleum engineer has a real task to face when he must value a property or a group of properties. Nevertheless it is done and with at least fair success. In California one of the most extensive valuations ever attempted has just been carried through under the able direction of Mr. M. L. Requa assisted by Messrs. Tom Cox, R. M. Hazeltine, and other engineers. The immediate occasion was the necessity of introducing order, so far as might prove possible, into the unprofitable chaos into which the independent producers had fallen. That phase of the matter is too large to be discussed here. It is mentioned briefly in our San Francisco letter on another page. It was proposed first to determine the relative value of the various properties as a preliminary to combining them into a single company or an association which is to be given the additional capital necessary to permit production, transportation, refining, and marketing to be conducted by the one concern. In previous attempts to value oil land various methods of estimating the oil remaining in the ground—the critical factor in such valuations—have been adopted. Perhaps the most common was to take the production of some small tract or tracts already exhausted or assumed to be exhausted, and use it as a basis. Another method was to determine the extent and porosity of the oil sands, test the amount of oil that could be drawn from a given amount, and use these factors. Still another method, extensively used in one of the American fields, was to assume an average life for the wells on the basis of experience and to buy on the basis of present production maintained through that life. All these methods are admittedly crude and imperfect and Mr. Requa and his associates refused to be satis-

fied with them. After much study, and with a wealth of data not available to earlier investigators, he has succeeded in working out a method which seems admirably to fit conditions in the valley fields of California at least. It is based upon obtaining curves of production from individual wells of some age in each field, deducing from them average curves, and using them to calculate total production for wells of less age, and for wells still to be drilled. The idea is not entirely new, but its successful application is, and reflects great credit upon Mr. Requa and his staff. It is well understood that in virtually every instance oil wells come in with a production materially above the average that they may be expected to maintain. In the life of most wells the first week is the most productive and each succeeding week the well yields less petroleum than for any preceding. There are exceptions, but the rule holds. Plotted, there is a steep decline followed by a curve of gradually decreasing steepness until, in such fields as the Lima of Ohio and the Trenton of Indiana, the line is virtually horizontal. What Mr. Requa has done is to obtain average curves for each field within which properties were to be valued. In one such he found that the percentage of oil in the ground at the beginning of each year of active production was substantially as below :—

Year	Per cent.
1	100
2	79
3	61
4	49
5	40
6	33
7	27
8	22
9	19
14	10
29	2

Using a curve deduced from such figures as a measuring rod, it was possible to take the production of a well in any year, and to calculate backward to the total already produced and forward to that remaining to be produced. It was possible to test these calculations in a large number of cases by comparing the calculated total past production with that recorded. Such calculations checked within 2% or 3% in every instance where there was not some clearly evident special factor to be considered. This check on past production gives, naturally, great confidence in the correlative estimate for the future. With this basis for determining the total amount of oil available in the ground, estimates of the cost of production and of profits were made on the basis of assuming all the land to be drilled in by the end of the year, and then getting the present value of the future production at rates for the individual year based upon the curve already mentioned. Various matters, such as difference in spacing of wells according to differing depths, were taken into account, all operating charges and cost of equipment were charged to cost of production, and future profits estimated upon the basis of various different selling prices for oil. This is a large and important factor. In the instance of the Nevada Petroleum Company, for example, with an estimated reserve of 25,000,000 bbl. of petroleum, and the requirement of $7,000,000 to provide additional equipment, the present value at the current price of crude oil is only $2,743,000. If, however, the price at the well can be raised to 70 cents per bbl., and Mr. Requa estimates that it can go to 80 cents before bringing coal into serious competition, the present value would be $5,800,000. We are glad to present these details of a valuation that is novel in many features. How far the plan may prove serviceable in other fields is open to question. It depends necessarily upon having a number of well kept records and also upon there really being an average rate of output which is significant. It would seem probable that differences in thickness and porosity of sand, as well as in pressure whether from gas or artesian water, might frequently make such

variations in output from well to well as to make the derivation of any average curve impossible or useless. The California sands are thick and porous and gas pressure is not so important a factor as in Oklahoma, to cite another American field, so that Mr. Requa's basis may well be sound in the field where he has used it, without affording a panacea. His use of the principle of present worth, his determination of well distribution according to depth, and his charging equipment to cost of production, are all as sound as they are unusual in petroleum engineering.

Supplanting German Products.

Strong efforts are being made by scientists and manufacturers in this country to re-capture the control of some of the trades that have during the last generation drifted to Germany. Reference has already been made in our columns to the government scheme for reviving the home production of coal-tar colours, and it is gratifying to record that sufficient support has been given by the woollen, cotton, and dyeing communities for the scheme to proceed, in spite of the absence of any guarantee of protection from the government. The business of Read, Holliday & Co., at Huddersfield, the largest producer of coal-tar dyes in the country, has been purchased, and a large output of a limited number of colours is being arranged. The colour interests loom the largest in the public eye among the German trades to be re-captured, but many other special businesses are receiving an equal amount of attention.

Many of the articles hitherto imported from Germany have been of relatively small importance from the monetary point of view, either to the user or to the producer, and the making of them has often required a larger amount of scientific care and research than the profits were likely to afford. The manufacture of glass of especial qualities and for especial uses may be taken as an example, such as the optical glass and the glass instruments used in the chemical laboratory. With a view of removing the inconvenience caused by the stoppage of imports of chemical glass from Germany, the Institute of Chemistry established a committee to conduct researches as to the constitution of glasses with various characteristics, especially with regard to their resistance to the action of chemicals and to wide variations in temperature, and to their ability to preserve their transparency. Under the leadership of Professor Henry Jackson, of King's College, London, a large number of formulas have been investigated, and eleven of these have been published. One of them, suitable for the manufacture of miners' and other lamp-glasses, may be quoted as an example: Sand 65 parts, alumina 1 part, calcium carbonate 0·6 part, arsenious oxide ($As_2 O_3$) 2 parts, antimony oxide ($Sb_2 O_3$) 1 part, potassium nitrate 3 parts, anhydrous borax 26·68 parts, boric anhydride 5·5 parts. It is believed that, with the formulas so far obtained by the committee, all the important glasses used in the laboratory or for industrial purposes can be manufactured. We are informed that the firm of Baird & Tatlock, of Glasgow, has already commenced the production of glass apparatus used in the chemical laboratory. As regards glasses used for optical purposes in the manufacture of microscopes, telescopes, binoculars, range-finders, and photographic lenses, the English firms have, since the year 1880, gradually lost their foremost position, for the German makers have conducted highly scientific investigations with regard to the optical properties of glasses, and the factories at Jena have now nearly eighty standardized types. The researches in connection with rapid lenses have been of particular scientific interest, and if it had not been for the results obtained, such things as cinematographs would not have been possible. Some years ago the Royal Society appointed a committee on optical

glasses, with the object of reviving an interest in the subject among British glass-makers, and many representations have been made to the authorities of the National Physical Laboratory, but little or nothing that was effective was ever done. At the present time the home of the study of technical optics in this country is the Northampton Institute in Clerkenwell, where Dr. Mullineux Walmsley has done excellent work with the limited means at his disposal. It is to be hoped that further support, either public or private, will be afforded him.

Another article used in science and manufacture hitherto imported from Germany is the Seger cone, which is used for the determination of the temperatures of heated or molten mineral matter, and the cessation of supply caused great inconvenience in the pottery trade, as well as among chemists and metallurgists. The situation in Staffordshire was saved by the action of Dr. J. Mellor, of Stoke-on-Trent, principal of the pottery department of the North Staffordshire College, who undertook the manufacture of the cones, and he is now producing over 1000 per day. He already has orders for 200,000, with promises of repeat orders. Finally, we may mention filter-paper as one of the German products on which chemists in this country have hitherto entirely relied. In response to appeals by dealers in chemists' supplies, some of the paper-makers have commenced the manufacture of this filtering medium. Among these firms are W. & R. Balston, of Maidstone, who are known as the producers of Whatman drawing-paper, and Evans, Adlard & Co., of Winchcombe. The papers made by these two firms have been examined at the National Physical Laboratory, and are reported to be of the highest quality.

Something substantial is already being accomplished by English firms toward re-capturing trade that has been allowed to slip to Germany, and, to encourage the expansion of this new movement, we invite other manufacturers to tell us what they are doing in this direction. Probably few of the individual firms connected with these trades can afford the expense of scientific aids to research, but a combination of interests might be arranged to establish a common technical service. An excellent opening offers for the many professors, lecturers, and research students at our colleges to undertake this work voluntarily, as part of their own course of study and investigation, without special reference to any fee or retainer from the manufacturer. As extensive research has not been customary hitherto in connection with these lost trades, no consulting chemist could urge that such an arrangement would tend to take away his means of living. Moreover, the college researches would be directed into more practical and commercial grooves, and would become of service to the country.

Opportunities for Mining in China.

European strife places many matters of world-wide importance in the background. Were it not for the war, the attitude of Japan in connection with mining and commercial concessions in China would afford a leading topic of discussion. As it is, much anxiety is caused in English and American circles as to the objects and eventual results of the present policy on the part of Japan. Except for the fact that our Foreign Office has publicly stated its intention of seeing the equality of all nations fully maintained as regards their rights in China, little is known of the present position, and we must perforce refrain from discussing the political aspects. The time is opportune, however, to review the possibilities in connection with mining developments in the great eastern republic. It may be that the importance of China as a region affording opportunities for the investment of money in mining enterprises is exaggerated in certain quarters, so it will be well to consider care-

fully the conditions that have to be faced before too hastily hailing that country as an Eldorado of the future. Those who are contemplating investment of capital in mining enterprises in China must consider many questions. Is there adequate evidence of the existence of mineral deposits of sufficient value to offer a substantial hope of exploitation? Do labour conditions and other local factors influencing the cost of operation indicate that mines can be operated at a sufficiently low cost? Is there, in the case of the base metals and minor minerals, a reasonable expectation of adequate and growing markets that are safe from capture by imported products? Are the laws and regulations governing the mining industry such that mining operators can expect to conduct their enterprises under satisfactory and stable conditions? These are the most important factors to be considered, and it will be well to discuss them in turn.

That mineral deposits of sufficient richness to justify exploitation exist in China there is no doubt. In a paper on the 'Mineral Production and Resources of China,' published in the *Transactions* of the American Institute of Mining Engineers four or five years ago, Mr. Thomas T. Read has summarized the then existing knowledge of the mineral deposits of China, and as an engineer qualified by some years residence in the country, his views are of special value. He showed that coal is so widely distributed throughout China as to be almost everywhere available with comparatively little transport, and that its quality is generally good and in many cases excellent. One large mine of iron ore of good quality has been developed, and there is evidence that other deposits of similar ore exist, with a presumption that there are many such. Considerable amounts of copper have been produced by native methods in south-western China, though hampered by lack of transport facilities and a locally scanty fuel-supply. The same remark applies to zinc, except that the deposits appear to be of even greater value. In both cases railways, for which the preliminary arrangements have already been made, will afford the needed transport and will presumably solve the fuel difficulty. The lead deposits are of more problematical value, but offer promise. Nickel deposits have been found, though little definite knowledge relating to them is available. The tin deposits are well known, as they already supply a considerable part of the world's output of that metal. Improved methods of mining would undoubtedly yield considerable profits to an operating company. Silver deposits occur in many places, but so far none of them appear to compare with the world's great silver mines. Gold deposits are found chiefly along the northern and western borders in districts now difficult of access. These also offer much hope of profit under more favourable conditions, which may reasonably be expected to be eventually attained. Altogether it is evident that China is a mining region of great promise.

As to labour, it is generally known that Chinese miners are efficient, as the experiment of using them in South Africa fully demonstrated. The rate of wage in China is extremely low, so low in fact that it is unprofitable to employ machinery for any operation that hand labour can perform satisfactorily. Lack of transport makes supplies expensive in many districts, but this is so generally true of mining as not to need elaboration; and it is obviously difficult to generalize concerning an area of 4,277,000 square miles, part of which is as densely populated as Lancashire, while other parts consist of an almost uninhabited desert. Generally speaking, conditions present no unusually unfavourable features, and the low cost of labour is a great advantage that is certain to continue for a long time. As to markets, conditions are both favourable and unfavourable. China is being

re-made into a modern country and therefore presents a large opening for the use of metals and minerals. But the growing general business of China offers a market for finished products rather than for metals as such. In some cases where the Chinese crude article can be produced at a profit as compared with that from abroad, the foreign finished product does not enjoy any advantage. However, a copper mine may yield the metal at a low price per ton, but unless the mining company is prepared to undertake refining and the manufacture of wire, it cannot reap the benefit of the growing market in China for electrical equipment. Another factor is of particular importance in the steel industry. Railways in China are being financed almost entirely with foreign capital. The agreements under which the loans are made in most instances provide that firms of the country in which the loan is floated shall enjoy certain preferential privileges. As a result, track, bridges, and equipment have been built according to British, German, French, Belgian, and American specifications according to the source of the funds. This presents a highly complex, specialized, market to a plant in China. This is a situation that must be met in pioneer manufacturing in any country, but in China the conditions are peculiarly complex, for the reasons given. As a large number of railways are being built with British capital, this would be rather advantageous to a British owned and managed plant, and we are informed that construction of such a plant was arranged, and would have been commenced had it not been for the unfavourable conditions created by the war. China seems therefore to offer a better field for large investments and strong groups than smaller enterprises which might not be able to reach their market properly.

We come now to the fourth factor, having seen that the first three are generally favourable. Here is the fly in the ointment. The present laws and mining regulations of China are not conducive to the investment of foreign capital in mineral deposits. It would be tedious to review the steps by which the right of the foreigner to engage in business in China has been grudgingly allowed. Generally speaking, foreign firms can only engage in business in certain restricted areas, known as treaty ports, within which they are under the jurisdiction of their own consuls, not being subject to Chinese laws or paying any taxes to China other than import duties, which are low. The treaties concluded at the end of the anti-foreign outbreak in 1900 provided that China should revise its mining regulations in such a way that foreign capital should be free to invest in Chinese mining enterprises. In the years that have since passed several codes of mining regulations have been promulgated, the latest having appeared about a year ago. None of these codes showed evidence of having been prepared by persons gifted with an understanding of the mining industry of China or of any other country, and the restrictions imposed by them made mining investments unattractive to both Chinese and foreigners. The present code was reviewed at some length in the *Mining and Scientific Press* of June 20, 1914. The most serious of its many drawbacks is that it provides that the control of all mining companies must remain in Chinese hands, and it also vests the supervision of mining operations so completely in the hands of the Government Mining Bureau as to place the operators at the mercy of the bureau. Many of the minor officials of this bureau are able young men who have graduated in mining at the Pei Yang University, but they are usually lacking in either knowledge or experience of mining. Efforts will be made to have a new code prepared that will afford reasonable opportunity for the exploitation of mines, but until these are secured the foreign investor will be justified in maintaining a waiting attitude as regards the mineral deposits of China.

PERSONAL.

PHILIP ARGALL is in London.

H. E. ARROWSMITH is at Antsirabe, Madagascar.

G. B. ATKINSON has returned from Russia, and has received a commission in the Northumberland Fusiliers.

H. FOSTER BAIN has arrived in London.

CHARLES A. BANKS has been making examinations in North Saskatchewan.

C. BEADON is captain in the Hyderabad Volunteer Rifles.

LORD OSBORNE BEAUCLERK is captain of the 17th Lancers and is at present at Rouen.

J. MACKINTOSH BELL has left for Canada.

G. D. BENGOUGH is captain in the Royal Garrison Artillery.

A. M. G. BEVAN is returning from Liberia.

FRANCIS L. BOSQUI is here from Johannesburg.

W. B. BLYTH, manager of the Great Fingall, is expected in London.

J. N. BULKLEY, late consulting mechanical engineer to the General Mining and Finance Corporation, has entered into partnership with S. C. THOMSON, with offices at 120 Broadway, New York.

ANGUS L. BUTLER is with the Nigerian Regiment on active service in the Cameroons.

E. W. BYRDE is with the Royal Engineers.

C. H. CLAYTON is conducting development work in Papua for the New Guinea Options Syndicate.

L. MAURICE COCKERELL has left for Abyssinia.

WILLIAM CULLEN has resigned as manager of the Modderfontein dynamite factory, and is in England supervising the erection of a new cordite factory for the British Government.

RICHARD DAVEY is here for a short time from Bogoslowsk, Russia.

FRANK H. DIXON is with the Legion of Frontiersmen at Southampton.

ROWLAND C. FEILDING is captain with the special reserve of the Coldstream Guards and left for the front on April 27.

A. M. FINLAYSON has returned from Rangoon, Burma.

A. E. FIREBRACE is with the Royal Engineers.

J. G. FOLEY is with the West African Field Force serving in the Cameroons.

H. W. GEPP is expected from New York.

K. L. GRAHAM has been appointed chief consulting metallurgist to the Central Mining —Rand Mines group.

J. WENSLEY GRAY is with the 46th Punjabi Regiment, Nowshera, India.

FRANCIS D. GURREY is with the Royal Engineers.

C. F. HEATHCOTE has returned to London from Tasmania.

CHARLES S. HERZIG left for New York on April 28.

KARL HOFFMANN is in Petrograd.

P. K. HORNER has left for a tour through the United States.

J. P. HUTCHINS has returned to Russia.

A. F. KUEHN has left for the Messina mine in the Transvaal.

G. G. S. LINDSEY is in China.

W. J. LORING is on his way to Chile.

A. M. MACKILLIGIN is home from West Africa.

G. W. W. MACKINNON was interned in Austria on the outbreak of the war, and has only just returned to this country.

BENJAMIN MAGNUS has resigned as manager of the Mount Morgan mine.

JOHN M. NICOL has left Mexico, and is now in San Francisco.

T. C. OLIVER has been appointed Director of Mines in the Northern Territory of Australia.

C. E. PARGETER is with the Royal Engineers.

W. G. PATTISON is here from the Congo State.

F. M. PERKINS has left for the Rhodesian Broken Hill.

W. H. RIGG is returning from Tavoy, South Burma.

MAX ROESLER has been awarded the first Emmons memorial fellowship. He is a graduate of Yale, and was for some time on the geological staff of the Copper Queen mine, Arizona.

H. R. RUGGLES-BRISE is lieutenant in the South African Artillery.

HECTOR STEWART has returned to Melbourne from South Africa.

RALPH STOKES has a commission with the Royal Engineers.

WILLIAM THOMAS is spending a holiday in Cornwall from India.

SCOTT TURNER is one of the survivors of the *Lusitania* disaster, and is now in London.

R. C. N. TWITE has joined the Moulmain Rifle Volunteers, Burma.

POPE YEATMAN expects to leave Chuquicamata for New York about the end of May.

H. H. YUILL has a commission with the Royal Engineers and has left for France.

METAL MARKETS

COPPER.—Prices have shown a rapid and substantial advance during the month. The demand from consumers has been steady, and large quantities have been bought for delivery up to the end of this year and even during the first six months of next year. The demand in America is especially marked. Brass makers are particularly busy, and seem unable to take fresh orders for delivery this year. Inquiry is nevertheless urgent, and orders are going begging for large tonnage and on attractive terms. The situation has induced a wave of speculation, which has lent strength to the market for standard copper. Observers predict a period of coming prosperity in America in which copper will participate. In the rush to take advantage of this improvement prices are being pushed up feverishly at the expense of industry. American producers have become very independent. Electrolytic which was selling at 16 cents at the beginning of April realized 19 cents by the end, while Lake is reported to have changed hands at 22½ cents. In this country the quotation for electrolytic for the month rose from £76 to £87. Dealers anticipated a large demand from Russia with the opening of navigation. Results up to the present are meagre. Possibly buyers are awaiting military developments before placing their orders. Production is growing apace, but there appears to be some understanding among leading refiners. The rise in the market does not appear to be at an end. There will probably be reverses, but indications point ultimately to much higher prices being realized during the year.

The following are the average prices of cash standard copper: April, 1915, £75. 3s. 5d.: March, 1915, £66. 5s. 5d.; April, 1914, £64. 17s. 4d.

TIN.—This market has been under continuous pressure, and prices have receded substantially. In view of the general bullish sentiment, it is difficult to account for the weakness. There is some increase in London stocks, and the new regulations to control exports, although the authorities are working with the best will to cause the least possible inconvenience to shippers, are undoubtedly hampering business. In New York, on the other hand, there is a heavy demand for spot tin brought about by the curtailment of shipping facilities, and lots have been rushed over there by dealers to obtain the advantage of this premium. It is felt that the reserve stocks in New York will have to be increased considerably for the protection of consumers, in view of the altered conditions. A good deal of tin has been bought by Russia for shipment to Vladivostok and to Archangel, and more has still to be placed. The tinplate trade is doing well both in South Wales and America. The Welsh mills are consuming steadily, but, as prices continue to recede, they naturally hold off the market as long as they can. Consumers generally are not well covered. Banca and Billiton tin has been put in warehouse here, and in view of the American demand the premium on Straits promises to increase. The backwardation so long established has been replaced by a contango of about £2, but this shows signs of narrowing again.

Average prices of cash standard tin: April, 1915, £166. 10s.; March, 1915, £180. 10s. 10d.; April, 1914, £164. 3s. 7d.

SPELTER.—The position here hangs entirely on America, the only available supplier on an adequate scale. In normal times there is little surplus after supplying home customers, and since the brass trade both in America and here is so busy, there is not enough to go round. Prices consequently have risen and still continue to rise. For April the high level is a record, and the price has advanced from £42. 10s. to £68. Galvanizers are only occupied to the extent of 50%, otherwise prices would be still higher. Further substantial advances are expected. The demand for fine grades cannot be satisfied. Efforts are being made to still further increase production.

Average prices of good ordinary brands: April, 1915, £49. 17s. 9d.; March, 1915, £44. 2s. 7d.; April, 1914, £21. 10s. 1d.

LEAD.—The stringency in this market has been eased with the engagement of some tonnage for the London market. Demand has become quieter in the home trade, and expectations of large Russian business have failed to materialize. Supplies reaching this market are now adequate, although difficulty is being experienced in securing freight for the outports, and deliveries there are in arrears. Australian exports show a heavy decrease.

Average prices of soft foreign lead: April, 1915, £21. 2s. 1d.; March, 1915, £21. 17s. 7d.; April, 1914, £17. 19s. 8d.

SILVER.—The price has shown little variation during the month, at 23½d. per standard ounce, though, owing to the diminution in sales from America, the price hardened to 23⅞d. at one time. The stock of silver at Shanghai is reported to be worth £8,000,000, and the stock in London belonging to Chinese owners is given at £1,000,000.

ANTIMONY.—The price continues to advance and English brands are quoted £100 to £105 per ton. Practically the whole output goes to the makers of munitions.

QUICKSILVER.—Spanish quicksilver is quoted at £11. 15s. per flask of 75 lb.

PLATINUM.—185s. per oz., nominal.

BISMUTH.—10s. per lb.

COBALT.—96 to 98%, 7s. 6d. per lb.

ALUMINIUM.—£90 per ton.

NICKEL.—£200 per ton.

MOLYBDENUM.—Nominal price for molybdenite, for small lots, 125s. to 130s. per unit, to contain a minimum of 90% MoS_2. Ferro-molybdenum, 65 to 85% molybdenum, 18s. per lb. of molybdenum contained.

TUNGSTEN ORES.—Wolfram, 65% WO_3, 35s. per unit; 70% WO_3, 35s. per unit. Scheelite, 70% WO_3, 33s. per unit. Tungsten metal, 96 to 98%, 6s. per lb.; ferro-tungsten, 80 to 90%, 4s. 9d. to 5s. per lb. of tungsten contained.

IRON.—The prices of pig iron have fallen slightly during the last month, No. 3 Cleveland iron being now quoted at 65s. per ton, as against 68s. in the early part of April. A year ago the price was 51s. 6d. Rubio (Spanish) ore is quoted at 30s. per ton delivered at Middlesbrough. Cumberland hematite pig is 95s. and hematite ore 28s. per ton.

MANGANESE.—There is no public market for manganese ores, so no quotations are possible. Indian production has now to be shipped to English ports, and nothing can come from southern Russia.

FERRO-VANADIUM.—33 to 40% vanadium, 9s. per lb. of vanadium in the alloy.

FERRO-TITANIUM.—15 to 18% titanium and 5 to 8% carbon, at 6¼d. per lb. flat price.

SPECIAL CORRESPONDENCE

NEW YORK.

COPPER PRICES.—The price of metal has gone up, as will have been noted from daily quotations, and it has carried with it the price of shares. With Amalgamated quoted at 77 and Utah a trifle below 72, it will be seen that the coppers are enjoying their full share of the stock boom that has struck the previously barren waste of Wall Street. Opinions differ as to the soundness of this boom. More than a month ago the best informed copper producers foresaw a rise of price in the metal and it was determined that, so far as such things may be controlled, it would not be allowed to go beyond 18 cents. It must be admitted that it reached that figure quicker than was anticipated, though in January the Lake Superior mines took off the brakes and began to get out all the metal that was possible. Other districts followed the lead and now all the big mines, including the 'porphyries' of the West, are producing at normal capacity. Not much of the new copper is yet on the market and it will be 60 to 90 days before the influence is felt. It is difficult to say how much of the undoubted present demand is due to genuine revival of industry and how much is temporary and results from the war. In March the exports amounted to 66,584,000 lb., the largest since July last, when the amount was 76,485,000 lb. It is to be remembered that in the United States there is little or no speculation in the metal, in the sense at least of buying and warehousing it for a future rise. Copper is usually sold as made and when the demand decreases it is the mines that must take up the burden by cutting production. In the past few years Germany has absorbed approximately one-fourth of the world's annual supply, and, since 1911 in particular, there has been more than a suspicion that Germany bought regardless of present needs but in preparation for a future need, in relation to which first cost and interest charge were unimportant. There was undoubtedly basis for this belief, but it is now far from certain that the importance of this factor has not been exaggerated. Germany re-exported an enormous amount of copper in the form of brass goods. Trade is adjusting itself and goods formerly made in Germany are obtained from other countries which in turn must call on the United States for copper, just as Germany did. This seems to be the explanation of much of the demand, though it is not to be denied that manufacture of war munitions both in Europe and in North America is making heavy demand upon the copper market. If this were the only factor there would be a still larger premium upon Lake copper, which is especially adapted to cartridge making, than the market now shows. As to the future, opinion is hopeful. Local demand for wire is good. The world's *per capita* consumption of copper, as of other metals, continues to grow and new mines are not being found in like ratio. Temporarily too, Mexican production is curtailed, and after the war an enormous amount of rebuilding in the devastated countries will be necessary. That this will be possible is proved by the circumstance that, except in Belgium, the areas actually hurt by the war are small in each case in proportion to the total supporting country, while they are industrially so important as to be rebuilt eventually.

The big copper companies show good statements for 1914, despite the difficulties for the year. For example, the Anaconda output was 223,700,000 lb., an increase of 18,300,000 over 1913, while earnings amounted to $1·88 per share as against $2·61. Utah Copper had the best year in its history with an increase of 2,000,000 lb. in production and net profits of $8,678,491 as against $8,513,105, despite the fact that the average price realized was 13·26 cents per lb., as against 14·97 cents. That this has been accomplished without robbing the mine is indicated by an increase in ore reserves from 316,500,000 tons in 1912 to 342,500,000 tons in 1914, despite the milling of 15,000,000 tons in the interim, all of which speaks well for the engineers in charge. Chino is another of the mines which did in

1914 substantially as well as in 1913. The tons treated amounted to 1,907,300, pounds of copper made 53,999,928, net cost 7·35 cents, net earnings $3,222,579, average price 13·32 cents. The corresponding figures for 1913 were: tons 1,942,700, pounds copper 50,511,661, cost 8·5 cents, earnings $3,234,033, price 15·09 cents. Evidently a little higher grade of ore was used and a lower cost per ton maintained. D. C. Jackling points out that for the first seven months of 1914, Chino was producing at the rate of 70,000,000 lb. per year and that in three years the property has paid in dividends $8,500,000 which, with the present quick and liquid assets alone, equals the total investment for property and equipment, while less than 5% of the developed tonnage has been treated.

SPELTER continues strong. The leading producers are well sold through September and sales at as high as 9¼ cents for December are reported. It is difficult to believe that the general market will rule so high, though as one man phrases it "brass makers have been buying copper with which to dilute their mixtures." The new development has upset many old currents of trade. That part of its willemite production that the New Jersey Zinc Company formerly sold to Germany now goes to the Nassau works at Depue, Illinois, for treatment, while old gas plants in Kansas that have not been in commission for years are now running despite the fact that gas costs 11 cents per thousand feet. Even old coal plants are being repaired for use. At Bartlesville, Oklahoma, wages have been raised and doubtless other advances are to be expected. S. C. Edgar, long the head of the Edgar Zinc Co. owned by the United States Steel Corporation, has retired and is succeeded, at least for the present, by his son. It is whispered that a more modern and aggressive management was desired. The Butte Superior company arranged with the American Zinc and Lead Co. for smelting its surplus concentrate but part of the furnaces to be used promptly burned. Other arrangements have been made and an increased production is to be anticipated. Speaking generally, the rise in price of ore has brought out an embarrassing quantity of low-grade, and smelters do not look with any great enthusiasm upon the prospect of imports from Australia unless long time contracts can be secured. However, several lots are under contract and a new current of trade in ores and metals seems certain to result.

JOHANNESBURG.

THE BIG MINES.—The results obtained during 1914 at the Randfontein Central, Crown Mines, and East Rand Proprietary, the three biggest mines on the Rand, the companies being consolidations of comparatively recent date, may be conveniently reviewed together, in the table given herewith. As the Rand-

	Randfontein Central.	Crown Mines.	East Rand Prop'y.
Ore milled, tons	2,493,984	2,287,000	1,804,780
Assay-value ore milled	24s. 9d.	26s. 11d.	29s. 1d.
Gold extracted	£2,885,599	£2,975,687	£2,509,116
Yield per ton milled	23s. 2d.	26s.	27s. 4d.
Working cost per ton	16s. 7d.	15s. 7d.	19s. 4d.
Working profit per ton	6s. 6d.	10s. 5d.	8s.
Working profit	£813,774	£1,191,628	£736,166
Debenture interest	£176,736	£48,325	£63,610
Debenture redemption	£81,600	£85,050	£80,051
Capital expenditure out of profits	£303,757	£90,058	£79,696
Dividends paid	—	£799,090	£428,032
Total capital	£4,193,700	£940,106	£2,445,897
Debentures	£2,918,400	£914,950	£1,260,000
Ore reserve, tons	6,826,644	10,022,000	5,400,000
Assay-value ore reserve	28s.	25s. 6d.	28s.

fontein Central does not publish figures for the ore mined, this item is omitted from the table. Crown Mines reports a rejection of 10·6% waste, and East Rand Proprietary 8·8%. Judging by previous figures, Randfontein Central rejects about 8%. It should also be noted that East Rand Proprietary charges debenture interest to working cost, and the other two do not. It will be seen that Randfontein Central has been milling ore of substantially lower grade than the other two, and has had to put a larger share of the profit back into the mine. Moreover, it is saddled with three times as much debenture debt as the other two. Its inability to distribute a dividend is thus explained. Since the formation of the consolidation in 1911, the total distribution has been only 15%. The ore reserve at the Randfontein Central shows a higher assay-value than that of the ore milled; this is due to the richer ore having been inaccessible owing to floods. The feature of the Crown Mines report is the drop in the yield per ton and in the assay-value of the reserve, the figures for 1913 having been 29s. 7d. and 28s. 7d. At all three mines the amount of ore treated was less than the capacity of the mills, at the Randfontein Central 30% less, and at the other two 15%, owing to the scarcity of native labour.

RAND GEOLOGY.—After a silence of four years, Mr. W. Bleloch has made another appearance as an interpreter of Rand geology. It will be remembered that he advanced a theory to the effect that all the mines in the far east Rand had missed the Main Reef Series and were operating on an entirely different lode. He connected in imagination

the Van Ryn lode with the Du Preez Series, which is worked by the Rietfontein, a few miles northeast of Johannesburg. His attempts to find the connecting link, however, failed, but during the exploration another lode was found, the identity of which he did not at the time establish. He has now come forward with the theory that this new lode is the Nigel reef, which has been worked at Heidelberg 15 miles southeast for many years. Working on this theory he proceeded to Heidelberg with the object of finding the continuation of the Van Ryn lode, and has found a reef which he is satisfied is what he was looking for. Geologists do not take Mr. Bleloch seriously.

TORONTO.

PORCUPINE.—Full electric power is now available, and active development and production, which for some weeks were seriously interfered with by the power shortage, have been resumed. The demand for power is increasing rapidly with the installation of additional equipment and the development of new properties, and before long the existing electrical services will be insufficient for the requirements of the district. The utilization of Abitibi Falls by the Provincial Hydro-Electric Commission, in order to furnish an adequate supply to the mines, is projected.

The statement of the Dome Mines for March shows an improvement over recent months in the grade of ore treated, the production being $97,881 from the treatment of 23,223 tons of ore of the average value of $4·20 per ton. During the last year the working costs have been reduced by $1·25, and the management is making important changes in the manner of breaking and hauling ore, with a view to effecting further economies. A large crushing plant is to be placed at the 425-ft. level. Primary crushing will be done by a 54 by 36 in. Buchanan-Blake crusher, through which the ore will be crushed to 5 in., and will then pass over a grizzly and into a 500-ton ore pocket. The oversize will be treated in a secondary crushing plant. The ore will be collected from the stopes by electric storage-battery locomotives, hauling trains of cars carrying 5 tons. The report that the payment of a dividend was in contemplation proved to be without foundation. The Hollinger has at present 80 stamps in operation, 20 of these treating ore from the Acme. An additional 20 stamps is being installed, which will also treat Acme ore. Development work on the Hollinger has now reached a depth of about 830 ft. The central shaft, which will handle ore from the Hollinger, Acme, and Miller Middleton properties, is down to the 400-ft. level, and other levels will be run at 800 and 1250 ft.

COBALT.—The annual report of the Nipissing for 1914 shows a production of 4,689,333 oz. of silver, of the gross value of $2,516,064. The net receipts were $1,587,621, and the cost of production 19·8 cents per oz., being 4·29 cents less than the cost during 1913. The surplus was $1,602,776, an increase of $343,715. The ore reserves were estimated at 10,000,000 oz. During March the Nipissing mined ore of an estimated net value of $169,079, and shipped bullion of an estimated net value of $27,308. It is now shipping bullion to New York owing to the high rate of insurance on transatlantic consignments. The outlook for La Rose does not appear encouraging, as the search for new ore deposits has been so far without result. The annual report for 1914 shows a production of 1,368,247 oz. of the net value of $637,555. The cost of production was 37·2 cents per oz. The profit for the year's operation was $217,979, and over $500,000 of the amount paid in dividends was taken out of the surplus, which on December 31 stood at $1,040,380. The ore reserves were estimated at 859,919 oz. of the estimated net value of $166,784. During 1914 the Beaver mined approximately 908,000 oz. of silver, of which 390,000 oz. was sold, realizing sufficient to pay all costs, leaving the balance of 510,000 oz. stored in New York to represent profits. At the end of the year the company had on hand ready for milling 1,200,000 oz. The Chambers-Ferland is driving from the adjoining Nipissing property into new territory, in the hope of cross-cutting one of the productive veins running in from the Nipissing. The big electric pumps which are to be used in draining Cobalt lake, are now in position and connected with power.

SAN FRANCISCO.

PETROLEUM.—Conditions in the oilfields continue to be unsatisfactory because of overproduction and persistent low prices. There is at present a surplus production amounting to about 30,000 bbl. per day, and a further potential surplus from wells at present capped, of about 20,000 bbl. There is, furthermore, the haunting fear of additional great 'gushers' in the Midway field which upset the market for everybody without yielding their fortunate or unfortunate owners any proportional profit. It is worth recalling that the Lake View No. 1, which yielded 8,000,000 bbl. of petro-

leum, only permitted a distribution of $150,000 among its owners. At present California petroleum companies are in effect distributing their capital—of cash or crude oil—in the form of cheap fuel to the world. Better times are perhaps in prospect. A committee from the Independent Producers' Association, under the chairmanship of M. L. Requa, has been working for nearly a year on a plan for combining the principal small companies into one large and complete unit comparable to the Standard, Associated, K. T. & O., and Shell. It is a large task requiring first the harmonizing of numerous conflicting interests in the field and then introduction of new capital sufficient to bring the total investment up to $1000 to $1500 per barrel of daily production controlled. The valuation has been completed, and it is now reported from New York that Mr. Requa has the promise of additional funds up to $30,000,000, with which to finance the deal. It is expected that the Union Oil Co., General Petroleum, North American, and Nevada will form the nucleus of the new group. If, as now seems probable, this combination is effected and financed, so large a portion of both area and production would be controlled by the big groups that prices at least above the cost of doing business would seem to be assured.

ALASKA.—An early spring in Alaska is anticipated, and it is thought that steamers will reach Dawson three weeks in advance of usual. In southern Alaska attention is divided between the big gold mines at Juneau and railway building from Seward to Fairbanks. The Alaska Gastineau mill began operating on February 18, and it is said to be running most smoothly. The first unit is treating 2000 as against the anticipated 1500 tons per hour, and it is now thought that the completed plant will handle 10,000 as against 6,000 tons per day. It has already been announced that the plant will be duplicated. The mill is unusual in that crushers, rolls, and impact screens are used and the ore is kept dry until reaching the concentrating division. Also concentration precedes amalgamation in place of following it, as in many gold mills. While the practice is closely modelled after that now common in copper mines, it is worth recalling that in many essential features it relates further back to gold milling at Mercur, Utah.

COPPER.—The Mountain Copper Co., Ltd., is fortunate in that its new concentrating mill was completed and ready for operation early in April, so that the company is ready to take full advantage of the present welcome increased demand for copper. It will be recalled that previously the company had mined only ore of such grade as could go direct to the furnaces. The new mill, by making lower-grade ore available, adds to the reserve and so to the value of the property, materially. The ore is to be crushed near the mine with Symons disc crushers, and then sent to the mill, where it is further reduced to 60-mesh by means of rolls followed by Hardinge mills and finally concentrated by flotation, using Minerals Separation processes.

MEXICO.

POLITICAL CONDITIONS continue chaotic. There is as yet neither certainty as to when peace may be expected or from what source it will come. However, mining and other industries have discovered a *modus operandi*, if not a permanent basis for working. Mail service in Northern Mexico is now more regular than at any time in recent years. An observer describes Villa's army as no longer a rabble, but a well-drilled and disciplined force armed with modern weapons. Carranza's victories in February and March were obtained against Zapata rather than Villa, as when El Oro changed hands. It is perhaps too much to expect that in the land of *mañana* matters should be forced to conclusions with the rapidity pleasing to foreigners, but it is possible that the peace will be all the more lasting for the delay. In Baja California, matters are quiet and the mines are operating, though the irregularity in sailing of steamers causes periodic scarcity of supplies. The governor, General Ortega, has decreed that all fire-arms shall be given up and the export duty on bullion has been increased. With minor fees it now amounts to almost 10 per cent. At Pachuca there has also been a shortage of supplies, though one train-load got through from the North late in January. The Real del Monte has been operating the Loreto mill at full capacity, 1000 tons per day, and the Guerrero at about half or 200 tons. Santa Gertrudis was obliged to cut down to about 40 per cent. while La Blanca was doing well and Progresso resumed early in the year. Bullion could not be shipped and it was difficult to get money for pay-rolls. Food as well as supplies are scarce and labour trouble has been brewing and a wage increase may prove necessary. The important companies have been able to meet the situation as to supplies by borrowing materials from each other. Mail is irregular and in part is sent out by motor to Vera Cruz.

THE GEOLOGY OF PROSPECTS.

An attempt to formulate the criteria for discrimination between prospects that are worth developing and those that are not, with practical suggestions for meeting common situations of real difficulty.

By F. P. MENNELL.

IT is only necessary to look into one of the ordinary text-books to see how largely the point of view of the mining engineer is ignored by most of those who have discussed the problems presented by ore deposits. There are, fortunately, some exceptions to this rule, among which may be mentioned Malcolm Maclaren's 'Gold,' Waldemar Lindgren's 'Mineral Deposits,' and certain treatises on practical matters like H. C. Hoover's 'Principles of Mining' and T. A. Rickard's 'Sampling and Estimation of Ore in a Mine.' Many interesting particulars may also be dug out of official and other publications such as those of several Australian Geological Surveys. It may at once be admitted that generalizations made in one country or district may be speedily disproved by the hard logic of facts in other areas, and it is also true that orebodies of similar character even in a single region exhibit the most surprising differences in their behaviour underground. Nevertheless, if theory is to be of real help in practice it is essential that we should have the features of ore deposits reviewed in a severely critical manner. They must be considered with every aid that geology and mineralogy can give us, very much from the standpoint of the man who has actually to *buy* mining properties, and for this reason it is absolutely necessary to bear in mind what has been learnt from the almost numberless cases where hard cash has been expended in vain, as well as the features presented by those where it has brought a good return to the investor. Indeed, the main difficulty confronting the budding engineer, or the mining man who is new to reporting on undeveloped properties, is the fact that, whereas plenty of descriptions of the big mines are available, he can find nothing to help him in judging what are the essential features, if any, in which they differed in their upper levels from those that have failed. He has to learn this from bitter experience, usually at his employer's expense.

As has been often noted, all kinds of seeming anomalies occur in nature, and a more intimate study of ore deposits is necessary before these apparent inconsistencies can be seen in their true light and reconciled with the facts. The main thing is to be sure of the facts, to theorize as little as possible, and to overlook no point, however insignificant it seems, that may help to elucidate the problems which an orebody never fails to present.

THE ZONE OF OXIDATION.—In the examination of a practically undeveloped deposit, it is, of course, necessary to be satisfied in the first place that the average content of the ore, combined with the dimensions of the orebody, the working facilities, and the local

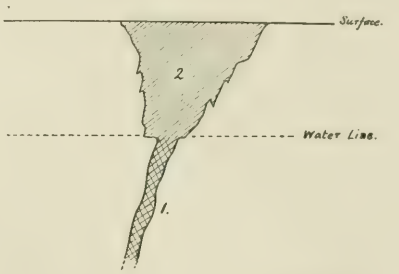


FIG. 1. ILLUSTRATING SPREAD ENRICHMENT.
(1) Primary ore, (2) Oxidized ore.

conditions, justify the hope of a profitable mining venture. Some of the data respecting the first two points are often very imperfect. The trenches, prospecting pits, and shafts may be too far apart to prove the continuity of the lode, and the work done may be so small in amount that the sampling of these openings may lead the incautious into assumptions which further development may almost immediately contradict. Where the prospectors or owners are willing to grant suitable options while further exploration is being done, a more speculative attitude may, of course, be taken than could be adopted where purchase outright is contemplated. When an immediate decision is required, the first axiom of the experienced man will be that there must be sufficient work done below water-level (or in unoxidized ore if that is reached first) to give definite indications of the probable grade below the zone that has been subjected to surface enrichment. It has sometimes seemed to me essential to have un-

oxidized ore exposed, and to have accessible workings below water-level as well, before an opinion can be adequately formed. This view impressed itself on me owing to an experience I had (it was my first, and therefore all the more impressive) with a quartz vein showing unaltered sulphides with rich gold at 50 ft., which gave out rapidly below 90 ft. The following were the actual assay results:

Depth. Ft.	Gold Content. Dwt.	Width. In.
65	79	24
70	100	24
75	28	30
80	24	30
85	54	42
90	34	39
95	14	39
100	16	36
105	9	48
110	3	38

Other work confirmed these indications, and the above was no doubt a case of secondary sulphide enrichment on a limited scale. As a practical matter, the recognition of such cases is complicated by the occurrence of secondary sulphides like galena or copper-glance, and less frequently pyrite, high up in the oxidized zone. It is scarcely necessary to add that in countries where the ground-water level is at such depths as 1000 ft., this rule would require modification. My own experience has been chiefly gained where water is generally met, except on steep slopes, somewhere about 100 ft. below the surface. Climatic conditions considerably affect the course of surface enrichment; it is most pronounced in the tropics, and may be entirely absent in recently glaciated regions.

Where obvious signs of oxidation are observable below water-level there is reason, apparently, to be as cautious as above that limit. An instance may be adduced from my own observation. Phenomenal results were being obtained by prospectors from a certain property, and my company obtained an offer from the owners to sell outright for £25,000. On inspecting the mine, which I described as "a very interesting proposition," I found that work had been done to a depth of 120 ft. with good results, but that although heavy water had been encountered, the ore was still decomposed and oxidized. I recommended that an option should be negotiated, and I stated in my report that I considered it "essential that we should carry down the work in one or more places to a depth of at least 200 ft., so as to get into solid unoxidized ore," before deciding whether or no to exercise the option. It may be interesting to relate what followed. The owners refused to grant an option, and we declined to buy. The former, however, had rich returns with which to attract business, and had evidently heard the story of the Sibylline books. Not being able to destroy any portion of their mine, except by continuing to crush as usual, they achieved the same result by raising the price, and, like the Sibyl of the story, succeeded in finding a purchaser, the property changing hands for £50,000. It was duly floated in London for a much larger figure, and a mill immediately erected. That mill ran for less than a year.

There is no more important point in connection with the examination of untried properties than this matter of surface enrichment. With gold ores it is especially prominent, and it cannot be too strongly insisted, as I have done in the 'Miner's Guide,' that, where serious development is being undertaken, the first level should be driven below the water-line in the unoxidized zone, unless, of course, the latter extends downwards for considerably over 100 ft. This applies to lodes with proved continuity as well as to those of which the downward extension has still to be demonstrated. The early work is otherwise likely to give rise to false hopes as to the grade of the ore, and there is no excuse, where capital is available, for driving at depths like 60 or 70 ft. as is only too often done. H. C. Hoover states that his "unvarying experience with gold is that it is richer in the oxidized zone than at any point below." ('Principles of Mining,' page 29). This statement is both explicit and authoritative. With ordinary veins and lodes occurring between well-defined walls, it may be accepted without any reservation whatever, and it sets a perfectly definite limit to the expectations that may legitimately be entertained regarding the results of development in depth.

Spread Enrichment.—Attention may be drawn at this juncture to a special case of the accumulation of gold in the zone of oxidation that must often have been observed. Examples have doubtless been described in print, but I do not remember attention having been drawn to the main features. I refer to the case which results, not so much in a marked rise of grade near the surface, as in a great increase in the width of the ore (see Fig. 1). Such a feature is not infrequent among large impregnation deposits, and it may be termed for convenience 'spread enrichment.' The gold released during the progress of the weathering and oxidation of a lode perhaps 10 or 15 ft.

wide may give rise to a body of ore above water-level that in some instances attains a width of 100 or even 200 ft. That this is not merely due to the surface enrichment of an equally large body of sulphides, which only constitute 'ore' in Mr. Rickard's sense of the term over a small part of their total width, is demonstrated by the fact that in some cases the section corresponding to the primary ore is not specially rich. Indeed, there are exceptional instances where the oxidized portions of the persistent shoots are actually poorer than the sulphide bodies below. This does not constitute a real exception to the rule that gold concentrates near the surface during the denudation of the upper parts of a lode. There is much more gold in the zone of oxidation, but it is distributed through a greater width of ore. Spread enrichment is principally seen in orebodies that contain considerable amounts of sulphides lower down, and it is usually accompanied by a corresponding concentration of iron oxides. It is also noteworthy that the hanging-wall rather than the foot-wall sections often tend to be most affected. This may at first sight seem anomalous, but it probably results from the favourable nature of the openings provided by the structural planes of the rock on the hanging-wall side, and the greater looseness of texture that is thereby caused during weathering. It may be useful to mention the names of a few mines that showed the effects of 'spread enrichment' in a greater or less degree near the surface. I may accordingly cite the Wanderer, Giant, Sabiwa, Golden Kopje, and Bushtick mines in Rhodesia. The economic importance of the process may be gauged from the fact that the Wanderer mine alone has crushed over two million tons of ore from the zone of oxidation since 1904.

The effects of spread enrichment can be traced in conjunction with those of other processes in many base-metal lodes, and sometimes extend well down into the sulphide zone. As a good example may be mentioned the once famous Burra-Burra copper mine in South Australia.

Erratic Results of Enrichment.—It would not be necessary to dwell so much on surface enrichment and the importance of getting down below the zone affected by it, when opening new ground, were it not for the extremely erratic results it produces. If we could state with any approximation to certainty that the grade of the unoxidized ore was likely to show a fall of say 50% as compared with that in the upper portion, it could by discounted to a large extent. Every mining man knows districts of only one 'big mine.' It is quite usual in certain regions to talk about the 'big mine' instead of calling it by name. Yet the old hands can often tell of surface shows that originally promised even richer results, but have long since fallen into oblivion. It sometimes happens that the big mine showed hardly any signs of surface enrichment, and that far more sensational finds were made all over the surrounding country, not one of which perhaps went down below water-level. I can myself think of several cases in point, and no doubt most mining men can do likewise. What is perhaps more important still, along the same 'line of reef,' with identical geological conditions in the surrounding rocks and precisely similar mineralogical characteristics in the lode itself, surface finds cannot be considered as a definite indication of the occurrence of ore in depth just because a persistent shoot has been developed at some particular point. It is not unreasonable to regard such a fact as affording grounds on which to base a favourable report to a development company, but it certainly does not justify the recommending of flotations before definite results have been obtained from further exploration. The names of Rand properties have appeared before now in the min-

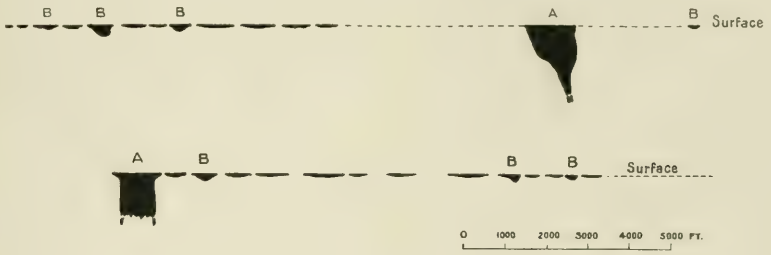


Fig. 2. Longitudinal sections along two lines of lode.
Ore shown in black; (A) persistent ore-shoots; (B) non-persistent shoots that went below water-level; the remaining patches of surface ore did not extend below the water-level.

ing casualty lists, like less famous concerns.

The sketch in Fig. 2 shows two continuous lines of lode with the positions of the ore-shoots roughly indicated. The persistent shoot in each case has a mine of 'international reputation' upon it, but development at other points along the strike has led to no corresponding good results.

EXPECTATIONS FROM LENGTH OF STRIKE.—A statement frequently made with regard to orebodies is that expectations regarding their persistence should be based on their length of strike. This is most generally applied to the case of mines on which a substantial amount of development work has been done, and may in certain cases be useful as providing a convenient factor for estimating the probable extension if an actual valuation has to be made. Such a method of calculation offers, however, a very slender basis in practice, and when it comes to newly discovered orebodies it has no validity at all. Surface results must then be the criterion if we are not to be faced by the formula of 'wait and see,' and experience tends to show that surface results are no definite indication of the length of shoot below ground, or even the existence of a persistent shoot at all (see Fig. 3). Veins with

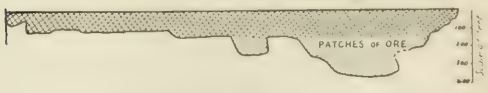


FIG. 3. LONGITUDINAL SECTION THROUGH WORKED-OUT AUSTRALIAN MINE.
A typical case of great length of strike with small downward extension. Single hatching represents unoxidized ore, cross-hatching oxidized ore.

a length of strike running into thousands of feet and giving good results all along the surface often show virtually no gold at any point deeper than, say, 50 ft. On the other hand, very short shoots of ore may persist for considerable depths. I have known, for example, a shoot 50 ft. long extend downward for 500 ft.; shoots about 100 ft. long for 700 ft. or more, and so on. A striking instance, which I actually examined, was that of a shoot so short that the whole of the ore was taken out, except for a fraction of the distance, in sinking the shaft! It nevertheless persisted downward for 200 ft. or twenty times its average length of strike, and it has been further opened up since.* Very short shoots of ore do not make big mines; they must obviously be on such of the long shoots as happen to persist. Hence, perhaps, the conception that length of shoot is related to persistence. In point of fact, no length of strike however great is a guarantee that any ore of profitable grade exists below the zone of surface enrichment. Generally speaking, if primary ore of good grade exists, its occurrence is limited to a fraction of the length that owes its value to surface enrichment. There are exceptional cases, of course, and in some of them the length of shoot may show no diminution whatever when the primary ore is reached. In the case of lenticular quartz veins an increase of length may even be observed. Such veins, however, are of most uncertain character, and a marked fall in grade usually accompanies any such increase. I can remember an example where a vein of 60-ft. strike at the surface lengthened to 250 ft. at the fifth level. The decrease in yield more than compensated the greater length, the grade being one-sixth of that obtained at the surface. Indeed, a little lower down it fell below the point at which profitable working was possible.

BASE METALS.—What are commonly called the 'base metals' behave differently from gold in respect to enrichment, and it is difficult to make such precise statements regarding them. It sometimes happens, especially in the case of copper, that the oxidized ore is by no means the richest. Much leaching may have taken place, though very rich bunches of malachite, etc., usually occur here and there. The top of the sulphide zone is often extremely rich, and secondary sulphide enrichment may extend to great depths. An intervening zone of leaching may sometimes, however, remove much of the copper from the parts of the lode between the oxidized and sulphide ores (see Fig. 4). This makes it more difficult to gauge the prospective value of deposits from work done near the surface. Lead is especially apt to show rich 'oxidized ores' below water-level, mixed with sulphides or before sulphides are reached.

In dealing with metals like tin and tungsten, quite a different set of conditions obtain, as sulphur seldom if ever enters into the composition of their ores. In numerous instances extraordinarily rich tin and wolfram ores are found along the outcrops of lodes with scarcely any traces lower down. Thus there are areas in the Congo State where solid lumps of cassiterite nearly as big as a man's head occur on the surface, whereas there is hardly a sign of the mineral below ground. I have seen masses of pure wolframite weighing up to

* My friend, Mr. James Cook, has drawn my attention to the case of a small mine in which a shoot only 15 ft. long was profitably worked to a depth of 500 or 600 ft.

200 lb. each extracted from the outcrops of extremely poor lodes. Of course these metals are often most irregular in their distribution, and the patchy character of the original ore may have had something to do with these occurrences. Nevertheless, the entire want of success of extensive prospecting based on rich surface finds and successful sluicing operations in many areas seems to indicate pretty clearly that surface enrichment must be taken into account. In fact, the analogy with gold is apparently close. The enrichment may be partly mechanical, especially with tin ores, but the great size of the individual crystals compared with those found at lower levels often prevents the application of such an idea. With regard to deposits of these metals in general, I may recall the maxim of an experienced engineer who strongly advised me to have nothing to do with tin lodes that contained felspar. With the substitution of 'unaltered felspar' for the unqualified term, I believe there is much to be said in support of this generalization. There are in England, as well as in many other parts of the world (Queensland, for example), impregnations of tin ore in granite accompanied by extreme alteration of the felspars and destruction of the ferro-magnesian minerals, and these have often been profitably worked, providing much of the ore in a number of mines. There are also well-known deposits in greisen and in topaz-bearing rocks, like that of Mount Bischoff. When, however, the results of the exploitation of tin in unaltered pegmatites and similar matrices are considered, it is fairly safe to say that they have invariably proved failures even where surface indications have been exceptionally promising.

Below Water-Level.—When the miner once gets below water-level and continues to obtain good results, he is usually entitled to assume a considerable further persistence of the ore in the case of gold. Apart from the effects of cross-channels, etc., the precious metal only seems to be materially affected by enrichment processes below water-level when it occurs in the form of tellurides or is associated with considerable amounts of sulphides, especially those of copper. Even then the enrichment is not usually significant in amount. It is seldom very marked where pyrite is practically the only sulphide, though C. B. Horwood states that in the case of the Rand banket the top of the sulphide zone was clearly affected. It must be noted, however, that though it may not be of much consequence, the secondary deposition of gold below water-level is perhaps more general than is usually recognized. Thus we have the fact that even with clean quartz the 'fines' are often abnormally rich, and this clearly indicates the presence of gold in the cracks. It is instructive in this connection to take an ordinary sample and pan it off without crushing, cleaning all the larger pieces of quartz well before picking them out of the water. It is surprising how large a proportion of the gold may be recovered in this way, even from quartz obtained from 500 or 600 ft. below surface. Nevertheless, it does not as a rule

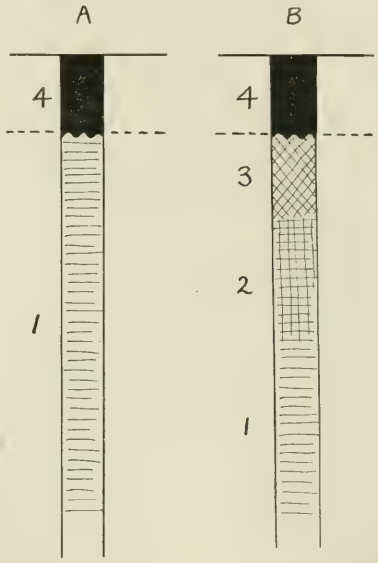


Fig. 4. (A) represents a common type of gold deposit, and (B) a common type of base-metal lode.
(1) primary ore, (2) zone of secondary sulphide enrichment, (3) zone of alternate leaching and re-deposition, sometimes absent, (4) zone of oxidation, marked surface enrichment in the case of gold.

materially affect calculations as to the prospective value of an orebody unless there is very little gold found remaining in the solid lumps of quartz when panned separately. A high proportion of gold in these solid lumps near the surface undoubtedly is a strong indication of continuance in depth, unless secondary silicification is to be suspected.

Effects of Leaching.—In the examination of ore deposits sufficient attention has not been given to the effects of leaching both above and below water-level, except as refers to the formation of ferruginous gossan capping a deposit of sulphides. This provides the most obvious example of leaching accompanied by oxidation, the concentration of the iron oxides being often connected with the almost com-

plete abstraction from an outcrop of the other metals that occur as sulphides below. At the same time the precious metals that may accompany the sulphides often become greatly concentrated in the oxidized zone and sometimes even below it. Well-known examples of this are afforded by the three famous Australian orebodies of Mount Morgan, Mount Lyell, and Broken Hill, in all of which the presence of the precious metals led to their development. Where gold or silver is absent or insignificant in amount, much greater courage is required in sinking through a zone impoverished by leaching, such as the barren capping of the Miami copper lode in Arizona, where the first workable ore was found at 210 ft. Most encouragement is to be got where the cavernous and decomposed nature of the vein-stuff shows clearly the former presence of minerals that have since been abstracted. This is sometimes demonstrated in a very unpleasant manner by the ground being insufficiently solid to withstand caving during sinking. It is not always easy, however, to persuade the people who are putting up the money of this fact, particularly where there was good ore exposed not far below the outcrop, or at least good patches of ore, as is usually the case. There recently appeared in a mining paper the plaint of an engineer deploring that miners would not sink through barren quartz outcrops in the same way as they did through ferruginous gossan. Most of us have met with sufficient discouragement in opening quartz veins with plenty of gold on the surface, and have little desire to venture far with barren quartz. Needless to say, with gossan as with quartz, in solid undecomposed rock with no indication of ore, it is futile to proceed further; there must be evidence that substantial amounts of sulphides really existed at one time or another.

Appended is a table of actual assay results down to a depth of 150 ft. in a copper lode. The width sampled, that of the shaft, was in each case 10 ft., the lode being much wider. The relations to water-level and the concentration of gold and silver below the leached zone are specially interesting. There was no gold, and mere traces of silver, where figures are not given for those metals. It may be noted that the leached zone extended much deeper at other points than it did in the particular shaft sampled, and that the lode proper was sometimes much leached, whereas the adjacent wall-rocks had received considerable accessions of secondary ore, thus affording a good example of the effects of 'spread enrichment.'

As a practical matter, the importance of recognizing that leaching processes have been at work in the upper part of a lode is often accentuated by their differential action. As has already been noticed, in connection with the formation of gossan, the iron and precious metals tend to remain behind near the surface while the more soluble copper, lead, and zinc are carried down. In deposits where tin accompanies copper, the tin usually makes a much greater show in the oxidized zone, for similar reasons. Indeed, cassiterite is some-

TABLE OF RESULTS FROM A LARGE COPPER LODE.

	Depth Ft.	Cu. %	Au. Dwt.	Ag. Dwt.
Oxidized Ore	10	0·4		
	15	1·3		
	20	5·0		
	25	5·8		
	30	5·3		
	35	4·8		
	40	4·8		
	45	3·8		
	50	2·1		
	55	1·7		
	60	3·5		
	65	3·0		
		—Water-level—		
Leached Zone	70	0·1		
	75	0·1		
	80	0·1		
	85	0·1	Trace	19
	90	0·1	Trace	17
	95	0·2	1	27
	100	0·6	3	23
Sulphides	105	6·0	½	16
	110	7·5	Trace	13
	115	6·4		
	120	6·3	Trace	5
	125	3·8		
	130	3·3		
	135	3·6		
	140	3·4		
	145	5·1		
	150	5·1		

times prominent in the iron capping of copper lodes which really contain only traces of tin for many hundreds of feet below the surface. This feature has often been recorded in the case of Cornish lodes, which thus show a reversal of the relative disposition of the two metals in the primary ore. In lead-zinc deposits, the oxidized zone usually shows a predominance of lead, though that metal does not maintain its relative abundance at depth. There are well-known instances of mines which near the surface produced only lead, but in depth yielded little but zinc. This is unquestionably due in many cases to the removal of zinc by leaching near the surface. Some of the leached-out zinc is often reprecipitated at a greater depth, with the result of still further

increasing the proportion found lower down.

It occasionally happens that the matrix is affected rather than the metallic mineral. This has the desirable effect of causing a relative enrichment even of such freely soluble metals as copper and zinc. Thus I have known a zinc lode in limestone capped in part by a residual deposit allied to laterite, from which all the lime had been abstracted, though the zinc was still abundant in the form of silicate. In another instance that has been brought to my notice, that of a large copper deposit, the richest section of the orebody was a cavernous mass containing malachite in exactly the same manner as the surrounding rock, but minus the original limestone matrix. The high assay-value was entirely due to the leaching-out of the latter, and affords one of the clearest examples of relative as opposed to absolute enrichment. Another effect of leaching of economic importance may finally be noted. In certain gold deposits leaching has caused the vein-stone to become so soft or friable, and thus so readily crushed, that a grade of ore can be treated which would be quite unprofitable if the matrix were harder. I know of at least one producing mine where this is the case.

Distribution of the Metallic Content.—An important consideration in many lodes is the distribution through the vein-stuff of the valuable mineral. The coarseness or fineness of the product obtained in treatment may involve important modifications in the metallurgical methods adopted, but this has not usually to be taken into account in a preliminary valuation. Of much more moment is the uniformity or otherwise in the dissemination of the metallic content revealed by sampling. Mere computation from the assay results might lead to precisely the same value being attached to two lodes which, to the experienced eye, differed greatly in their prospective merit. Where the various samples show marked uniformity, and few fall below what might reasonably be considered as a profitable grade, having regard to the general conditions prevailing, they may be taken at face value. When, however, they are erratic, especially where the general average is largely dependent on a few rich assays, it is necessary to apply the results with considerable caution. This is particularly necessary where the widths are small, and where the rich samples come from the narrowest parts of the lode, as is by no means infrequently the case ; though my own experience is that, except where the ore-shoot is nearing its termination, the widest parts are quite as likely to be rich as the narrowest. Even then, it is found in practice advisable to use some system of 'reduction' of assay-values, though such systems are admittedly arbitrary and liable to abuse.

It is often found that the valuable mineral occurs concentrated in such a way that sampling shows rich sections along the course of the lode, separated by much more extensive poor stretches. Where the poor sections are of such low grade as to be unprofitable, it is often evident that the orebody as a whole is of little or no real value. In some instances, however, it becomes an important consideration to determine whether there is any regularity in the disposition of the richer patches. In general their occurrence is capricious, and their development may involve so much dead work as to render mining operations unprofitable even where they are extremely rich. I can remember some claims where the owner extracted over £3000 worth of gold from a very small patch of ore, and then spent £5000 in looking for another one. Where there are indications of the rich stuff continuing downward in a definite direction, or of the regular recurrence of the patches of ore, it may put a different complexion on the matter. Such examples as the concentrations along the 'indicators' of Ballarat are well known, and as instances of regular recurrence may be cited the saddles-reefs of Bendigo. The recognition of the probabilities in such directions involves a study of the geological conditions under which the orebodies occur; in other words, of their external relationships, rather than of the internal structure, which has so far been exclusively under consideration.

It had originally been my intention to discuss these in some detail, but this article has already run to such length as to render it impossible to devote more than a few lines to the subject. It may be said that while it is always advisable to look for changes in the nature of the enclosing rock, it is seldom that such changes seem to exert any direct influence. Differences in the physical condition of the rock are more important, though it is often difficult to discriminate in this connection between cause and effect. Points that are more frequently to be noted as of importance are changes in the direction, or in the dip of the lode, and perhaps more often still, the junction of small strings or 'leaders' with the main body. The possible value of such indications should never be overlooked, either in the preliminary inspection of a deposit or in carrying out development work.

THE LEACHING-PLANT AT CHUQUICAMATA

A detailed description of the construction of the leaching-plant of the Chile Exploration Company.

By LINCOLN C. ROGERS.

INTRODUCTORY.—The process by which the Chile Exploration Co. intends to treat the two hundred million tons of copper ore at Chuquicamata has already been described in a paper published by the *Mining and Scientific Press* by Mr. E. A. Cappelen Smith, of New York, who is mainly responsible for its application on such a large scale. A précis of Mr. Cappelen Smith's article appeared in *The Mining Magazine* for June last.

The plant, on the successful construction of which the practical outcome of the process depends, contains many novel features,

THE CHARGING AND DISCHARGING BRIDGES ON THE LEACHING VATS. "The loading and discharging of the ore will be done by means of structural steel bridges, spanning and traversing the six leaching vats."

and a general description of some of these may be of interest to engineers. The first unit, one of four to be ultimately installed, was designed under the direction of Mr. David Gilmour, consulting mechanical engineer in New York and Chile, and is capable of handling ten thousand tons of ore per day of eighteen hours, allowing six hours per day for inspection and general repairs. The mechanical equipment consists of a steel trestle 1200 ft. long, steel ore-bins with a capacity of 16,000 tons, gyratory crusher house containing two No. 10 McCully gyratory crushers, roll crusher house containing four 48 in. Symons disc crushers and 8 sets of 72 in. Garfield rolls, sampling tower containing three sets of Vezin samplers, together with an extensive conveyor-belt system for handling the ore and delivering the waste to the tailing heaps. Nine vertical lead-lined pumps were designed by the Worthington company for handling the acid solutions. Two of them are 6 in., three of 9 in., and four of 15 in. diameter. The whole of the equipment is electrically driven.

An acid plant for the manufacture of 30 tons per day of 50° Beaumé acid was also erected. The total quantity of acid required for the starting of the plant was estimated at 6000 tons. A necessary provision so far from the base of supplies was the extensive workshop and foundry, fitted with modern machine tools, and capable of effecting at short notice any repairs or replacements that became necessary. The centre bay of the workshop was provided with a 30-ton electrically-operated crane by which means all locomotive and ore-car repairs could be easily handled.

The main feature of the work was, however, the very large amount of reinforced concrete required in building the solution sumps and the leaching and electrolytic vats. With the smelting plant, de-chlorinating plant, pump-house, and electrolytic vat-house, a total of 35,000 cubic metres of concrete was poured, 200 tons of steel reinforcement used, and over two million board feet of timber made-up into forms.

The plant is erected at an elevation of 9500 ft. above sea-level, and is roughly 500 ft. lower, and about 4 kilometres distant from the *llamperas* containing the orebody to be treated. The ground around the plant has a fairly uniform slope of 6¼%, and is formed of detritus from the foot-hills of the Andes, consisting of large sharp pieces of granite firmly cemented together by gypsum, which permeates the whole mass. This deposit is of considerable thickness, and bedrock for foundations was quite out of the question. Although dry and loose on the surface, the deposit was found on excavating to be a hard compact mass capable of withstanding considerable pressure. Foundations were, however, arranged for not more than four tons per square foot.

The solution sumps, of which there are nine, for storing the acid solutions both before and after treatment, vary in size, the largest being 150 ft. by 130 ft., and the smallest 150 ft. by 70 ft., all 12 ft. deep, built to-

gether in line with two gaps or passage-ways to break the continuity of the concrete. The six leaching vats are of uniform size, each being 110 ft. wide by 150 ft. long, and all 16 ft. deep, set in line in two sets of three vats each, a passage-way being provided between the two sets. They are placed parallel to the solution sumps at a distance of 80 ft. away and on a bench 20 ft. lower down.

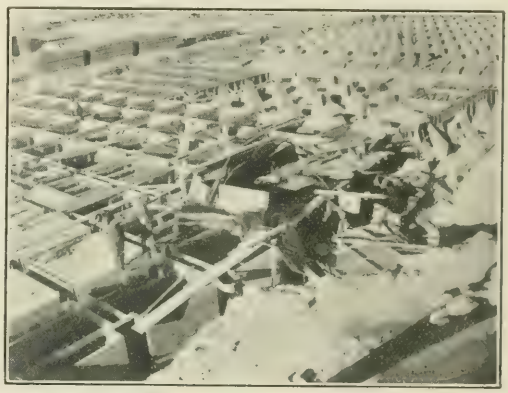
CONSTRUCTION OF THE VATS.—These solution sumps and leaching vats are probably the largest of their kind in existence for this class of work, and special care was taken in the design and construction to guard against earthquake shocks, and also to render them easily accessible from all sides to allow of inspection for leaks and possible settlement due to repeated loading and unloading.

The excavations were carefully prepared, and benches 950 ft. long and of sufficient width to accommodate the footings were cut back into the solid. A pad of concrete varying in thickness from 18 in. to 2 ft. was then laid to take the outer wall and counterforts and partition walls, 6 ft. wide for the solution sumps and 10 ft. for the leaching vats. The vat floors are 11 in. thick, set on concrete beams 12 in. deep, which in turn are supported on concrete piers standing 4 ft. above the ground, thus giving an available head-room of 5 ft. from ground-level for inspection purposes and solution pipe-lines. The piers supporting the vat bottoms are 4 ft. square at the base, tapering to 22 in. at the top, and are placed at 9 ft. 6 in. centres for the solution sumps, and 8 ft. 9 in. for the leaching vats. The piers are points over which the beams cross, thus forming the floor into panels of these sizes. The tops of the piers contain four 1 in. diamond bars as dowels projecting into the beams and floor.

The floor panels are reinforced with $\frac{5}{8}$ in. diam. and $\frac{1}{2}$ in. diameter diamond bars on the bottom and top sides respectively, placed at $4\frac{1}{2}$ in. centres, with the outer panel reinforcement hooked into the walls. The beams are reinforced with Kahn bars and 1 in. diamond bars as continuous girders, having the diamond bars hooked into the buttresses, which are placed opposite to the ends of the beams.

The walls have a thickness at the top of 9 in., increasing to 18 in. at floor level, and thence parallel to the foundation pad. The buttresses slope from the top of the wall to the outer edge of the foundation pad, placed at the same centres as the floor beams and with a width of 2 ft. 6 in. The buttresses are carried in solid under the floor-level to the first pier, in order to provide a cantilever to resist any tendency to overturning of the wall at the floor-level. The buttresses are reinforced with $1\frac{1}{2}$ in. diamond bars on the tension side and $\frac{1}{2}$ in. and $\frac{5}{8}$ in. bars on the compression side, while from these the load is distributed to the wall panels by means of Kahn bars placed horizontally at varying intervals up the wall. The interior walls are provided with a 6 in. haunch at floor-level, while the buttresses are haunched on meeting the floor pad so as to obtain a better distribution of the loading.

Outlets are arranged in the solution sumps for the pipe connections by means of plugs, and these were afterwards filled with special lead-lined castings. Arches were also provided in the outer and partition walls for inspection purposes, ventilation, solution-piping, and removal of the forms below floor-level. The vat forms were of substantial design, and



REPAIRING DAMAGE DONE BY WIND-STORM TO THE FORMS AND FOUNDATIONS OF THE LEACHING-VATS. "The vat floors are set on concrete beams which in turn are supported on concrete piers."

carefully made in sections, easily removable for re-erection. Forms were provided for two leaching vats and three solution sumps, so that the work of placing the concrete could proceed simultaneously on both lines of vats.

The sequence of the work was as follows: The piers, of which there are about 1700, for supporting the vat floors were first placed. The beam and floor panel forms then followed, supported on the piers and consisting of double 1 in. by 12 in. timber, broken jointed to prevent leakage. The pier forms had in the meantime been stripped in advance of placing the floor forms. The latter were well supported at intermediate points between the piers. The outer continuous pads for supporting the walls and buttresses were in the meantime being placed, containing the necessary reinforcement and dowels. The outer wall and but-

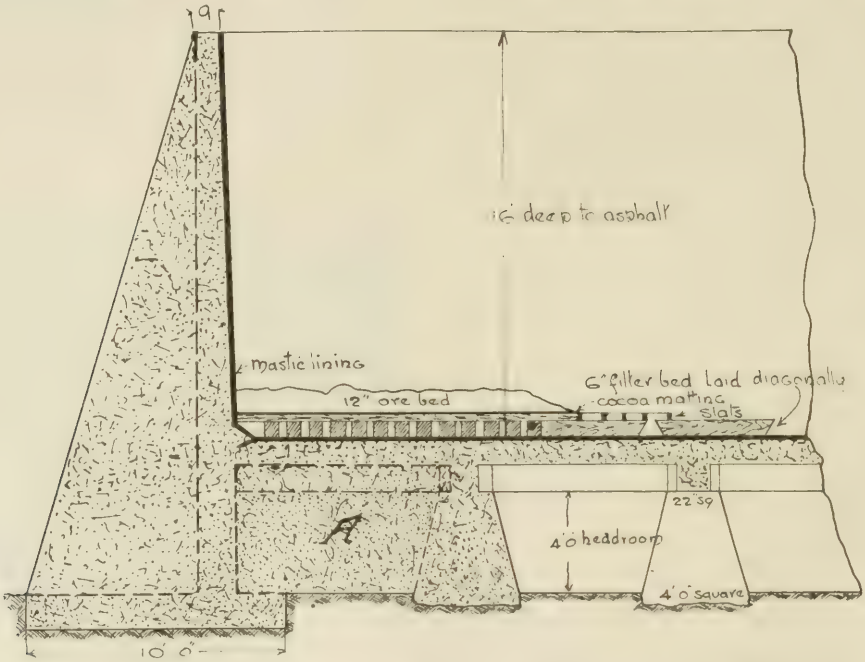
tress forms were then erected, firmly secured at the bottom to the dowels already in place, and well strutted from the top to inside floor forms, while on the outside the forms were well shored to the ground.

After the bottom-wall reinforcement had been set, the wall was poured up to floor level, and including the floor for a distance at one-and-a-half panels from the wall, thus firmly securing the forms from any chance of movement while the walls were being poured from floor level upward; in addition to which, it permitted the removal of the interior strutting for the purpose of erecting the inner-wall forms.

While the interior-wall forms were in process of erection, together with the necessary elevated runways on the completed floor panels around the vat sides, the placing of concrete was being proceeded with on the centre floor panels; and while the upper walls of vat No. 1 were being placed, the floor forms were being removed to vat No. 3, thus allowing forms to be kept well ahead and the placing following in order, down the line of vats.

Day shift only was employed as being more efficient, after a trial of the double shift system had been made. The day's work was parted-off by means of vertical bulkheads, forming keys in the centre of the panel between buttresses. The placing of the concrete was a very difficult matter, requiring close supervision, due to the thin walls and floor and the large amount of reinforcement used. Great attention was given to the spading or slicing in order to obtain a thoroughly dense concrete.

Placing was done by means of buggies and barrows travelling on runways placed around the vat sides, and arranged for feeding from hoppers, conveniently placed at a suitable elevation along the range of vats. These in turn were fed by means of side-tip cars on 24 in. track, from Chicago 3 cubic-yard cube mixers placed in a position overlooking both the solution sumps and leaching vats.



PART SECTION OF LEACHING VAT, SHOWING CANTILEVER PORTION OF COUNTERFORT AT *A*, CARRIED UNDER FLOOR-LEVEL AND KEYED TO FIRST PIER.

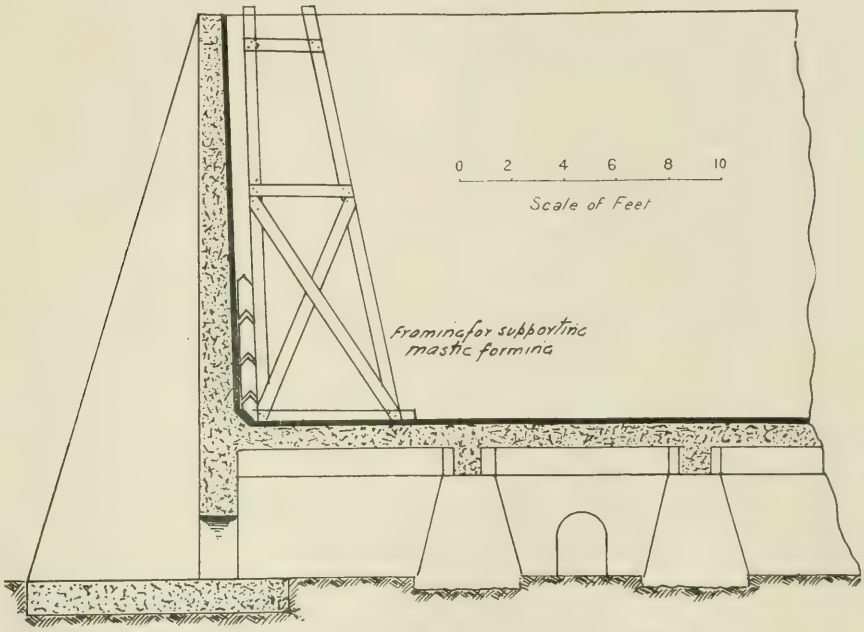
This arrangement was found to be the best and cheapest that could have been adopted under the circumstances, and especially so with the labour available. The Chilean labourer, while almost hopeless on day's pay, will work early and late and requires little supervision on task or contract work; consequently the method finally adopted permitted of a certain amount of concrete placing to be set out each day, in the rapid completion of which each individual had an interest, meaning shorter hours for the same rate of pay. In the earlier stages, work under the day-pay system was barely completed at the end of the day, but the same amount as a 'task' was

completed by noon. The amount each day was steadily increased until the working time was not far short of a full working day.

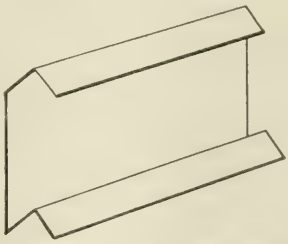
The tower and spouting system was considered for the work, and a tower 85 ft. high was erected for trial, but the high winds prevailing during nearly four months of the year and reaching at times a velocity of 80 miles per hour, rendered this system both difficult and slow. With the system adopted, it was found that a vat could be poured in from 15 to 20 days. A mix of 1:2:4 was used in nearly all of the reinforced work, and the cement was for the most part Danish. But the outbreak of war and consequent delay and stoppage of shipments made it necessary, in order to prevent interruption, to use cement that could be obtained quickly, and about sixteen different brands were, in the later stages, worked into the plant.

The production of a suitable aggregate was by no means the least of our difficulties. The presence of large masses of gypsum in the fissured granite necessitated hand-picking at the quarry and careful screening after crushing. The natural sand obtainable in large quantities in this district is a wash of fine granite chips from the hills down the many quebradas or water-courses, and it attains a thickness in many cases of over 20 ft. It was found, however, to be quite unsuitable for concrete, containing, as it does, a large percentage of soluble SO_3 in the 'fines,' and was only used in the mass concrete, and as a make-up for grading the artificial sand.

In a laboratory established on the property a long series of interesting experiments were made on the strengths of various mixtures of natural sand and artificial aggregates, and it was found from these that the introduction of the natural sand or rock into the mix had a destructive effect upon the concrete, which disintegrated rapidly in the presence of moisture.



PART SECTION OF WALL AND FLOOR OF LEACHING VATS
Showing method of placing the mastic lining.



SHEET STEEL FORM IN 3 FT. LENGTHS FOR FIXING WALL MASTIC

The large mass of data collected and the experience gained, together with the labour trained in the construction of the first unit, will be invaluable to the company in the extension of the plant.

MASTIC LINING.—The vats were rendered water-tight and acid-proof by an interior lin-

ing 1½ in. thick of mastic (a mixture of asphalt and natural gravel) mixed in a melting condition in rotating mixers. The mixture was then poured in behind special sheet-iron forms, in layers about 6 in. wide, passing around the vat, these forms being built up for each layer as required. In order firmly to attach the lining to the walls, and also to prevent any creep when exposed to the sun's rays, tie wires were embedded in the concrete spaced at 24 in. centres, and to these was secured a light triangular expanded-metal reinforcement which was embedded in the centre of the lining. The result was found to be satisfactory, and little or no sag was noticed, although the walls were exposed to the sun during a long period of the hottest portion of last summer.

The vat bottoms were treated differently, as it was found advisable to isolate the mastic lining from the concrete, on account of a tendency in the mastic to open slightly over the construction joints in the floor. This was probably due to the slightly harder mixture of mastic necessary for the bottom to sustain the load resting on the filter bottom, and also to the expansion and contraction in the concrete being more localized than was the case in the walls, due to the different and more rigid construction of the floor. The bottom lining was, therefore, laid on deadening felt or paper about one-sixteenth of an inch thick, and the expanded metal embedded in the 2 in. thickness of mastic only over the construction joints in the concrete. The tanks were tested on completion by being completely filled with water, and were found satisfactory in every way.

The filter bottom was arranged of 6 by 6 in. untreated timber overlaid with slats and cocoa matting, and 12 in. of ore is always left in as a protection against the grabs of the discharging bridge.

CHARGING AND DISCHARGING.—The loading and discharging of the ore will be done by means of structural steel bridges, spanning and traversing the six leaching vats. The total length of the six vats is 935 ft.

The bridges were designed and supplied by the Mead Morrison Company of Boston, Mass. The smaller or loading bridge has a clear span of 124 ft. with a cantilever of 20 ft. on the one end, and is mounted on eight heavy double-flanged wheels, 26 in. in diameter, with heavy steel axles extended to receive the propelling mechanism. The bridge is run on 85 lb. standard T rails. The propelling mechanism consists of heavy worm-gearing enclosed in dust-proof casings, and is driven by a 30 hp. induction motor in the motor house at the end of the bridge, and geared to propel the bridge at a speed of 50 ft. per minute along the trackway, in either direction. The ore, after passing through the sampling tower, is fed upon a 36 in. conveyor-belt running the whole length of the vats, and passes through a tripper placed on the cantilever of the bridge. The ore is thus delivered through the tripper to the short 36 in. conveyor running the length of the filling bridge and across the vats. The short belt driven by a 15 hp. motor is fitted with an automatic self-propelling reversible tripper which distributes the ore evenly into the vats.

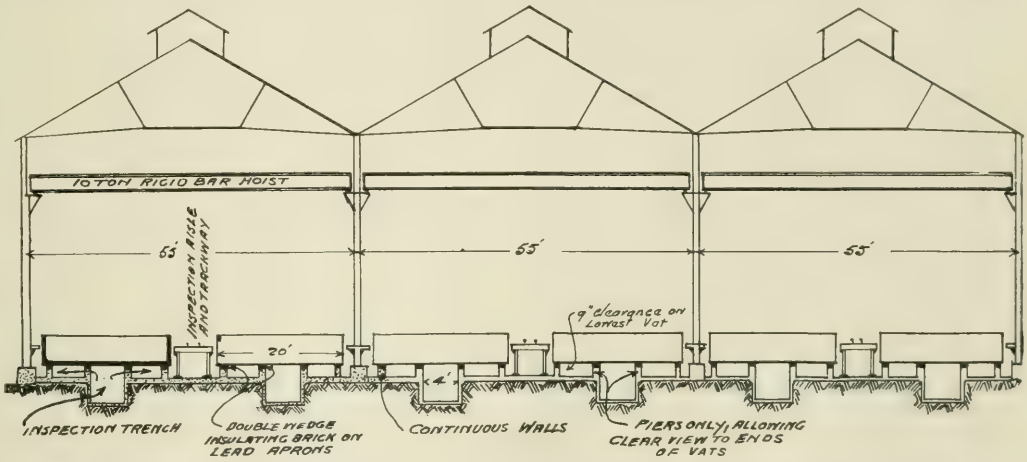
The unloading bridge for discharging the treated ore into the tailing-handling system, or into railway cars, as may be required, is designed to work over and outside of the loading bridge. This bridge has a clear span of 150 ft., and is mounted on twelve heavy double-flanged wheels, running on standard 85-lb. rails. The propelling mechanism is similar to that used for the loading bridge, but is worked by a 50 hp. motor geared to move the bridge at a speed of 50 ft. per minute in either direction along the trackway. The discharging is done by means of a 6-ton double-rope ore-grab, operated from an electrically-driven grab-hoist geared to a 200 hp. motor, and a trolley machine geared to a 125 hp. motor. The grab-hoist is geared to give a hoisting speed of 300 ft. per minute. The ore is discharged from the grab into a hopper placed at one end of the bridge, the hopper having a double-way chute leading either to the tailing conveyor system or to railway cars. The bridges are carefully designed and are practically fool-proof for operating.

ELECTROLYTIC PLANT.—Another interesting portion of the plant is the electrolytic vat house. This is a steel-frame building 540 ft. long and 160 ft. wide, divided into three bays, and containing the 510 electrolytic vats and cathode-making plant. Each bay of the house is provided with one 10-ton electrically-operated crane running the whole length of the building. The cranes will be used for lifting the anode and cathode bars, and also for removing vats for repair if necessary. The electrolytic vats are 20 ft. long, 5 ft. 3 in. wide, and 5 ft. deep, with walls and bottom 5 in. thick of reinforced concrete, and are arranged over inspection trenches, concrete-lined, which run the length of the building. Elevated platforms of structural steel, covered with concrete placed on corrugated iron, are provided, on which is laid a system of 24 in. tracks for the air locomotives, and special

carriages which will be used for the collection of the completed cathodes. Sixteen vats form a solution circuit, and are placed parallel to each other on their length, separated by a gap of 3 in. only. The highest vat in each circuit is set at an elevation of 25 in. above floor-level, and each succeeding vat of the 16 is stepped one inch lower, thus giving 9 in. of head-room under the lowest vat for inspection from the trenches. Two circuits of 32 vats and six circuits across the width of the building empty their spent electrolyte into a common launder of concrete lined with mastic. All of the cross-building collection-launders empty themselves into a main collecting-launder placed outside of the building, and the spent electrolyte is thus conveyed to the pump-house head vats to be pumped up to the main solution sumps. The vats are lined with mastic 1 in. thick, and have embedded a row of acid-proof tiles at the water line, to prevent the oil floating on the electrolyte from eating its way into the mastic. They are supported on insulating double-wedge bricks placed over lead aprons on the outer supporting walls, and piers above the inspecting trench wall, which support the centre of the vats. The building is divided into five electrical circuits, and the copper leads for distributing the low voltage direct current are 10 in. deep and $\frac{5}{8}$ in. wide, having two bars per circuit. The positive leads pass under the elevated platforms to the vats, while the negative leads are supported from the roof members of the building.

The flow of the solutions through the vat house is controlled from the reinforced concrete head-tank 95 ft. long, 61 ft. wide, and 12 ft. deep, built on similar lines to the solution sumps, and placed in close proximity to the vat house. It is, in turn, regulated by an automatic electrically-operated pumping plant, dealing with the solutions as they are delivered from the de-chlorinating plant.

Power Plant.—The power station, which will supply the current for the vat house and power for operating the other portions of the plant, is situated at Tocopilla, on the coast, a distance of about 120 miles from the mine. It is equipped with four sets of Zoelly turbines and Siemens generators. Each set will generate 10,000 kilowatts at 5000 volts, and the power will be transmitted to the sub-station at the plant at a pressure of 110,000 volts. Steam is supplied to the plant by Babcock &



Cross-Section of Electrolytic Vat-house Showing Arrangement of Vats.

Wilcox oil-fired boilers. The condensing water, of which four tons per second is required, is taken in at sea level through specially constructed intake works, having reinforced concrete settling and filtering basins. The main sub-station at the mill-site is equipped with high-tension transformers and necessary switch-gear for reducing the pressure to 5000 volts, together with the necessary switch-gear for distribution of the current to other subsidiary sub-stations at various points on the plant. Seven motor-generator sets are provided for generating the direct current for the electrolytic plant. The sub-station is an earthquake-proof structural framework filled in with panels of reinforced concrete.

The plant is due to begin operating for the production of copper on May 1, 1915.

The water for the erection of the plant was purchased from the Ferro-Carril Antofagasta-

Bolivia Company, and was delivered in tank-cars to the company's pumping-plant at a cost of one dollar United States currency per metric ton. For the operation of the plant, however, the company has installed a pipe-line 69 kilometres in length and 12 in. and 9 in. in diameter to the San Pedro intake, which will supply water to the 3000-ton steel storage tank, placed at a suitable elevation for distribution to all parts of the plant.

Molybdenum.

The directors of the Imperial Institute have issued a leaflet describing the uses of molybdenum and the distribution of its ores. The addition of molybdenum to steel increases the hardness, toughness, and elongation of the metal. Molybdenum high-speed steel, as used for machine tools, contains 8 to 10% of molybdenum. The ammonium salt of molybdic acid is used in laboratories as a reagent for the estimation of phosphorus in steel, soils, etc. It can be used also as a preservative of nitro-explosives. Molybdenum compounds are used for the production of a yellow colour on porcelain.

The only molybdenum ore of importance is molybdenite MoS_2. It is widely, though usually sparingly, distributed, and is known to occur in the following countries of the British Empire: England, Scotland, Australia, New Zealand, Canada, Newfoundland, South Africa, India, Ceylon, the Federated Malay States, and the Virgin Islands in the West Indies. It is also found in the following foreign countries: Austria, France, Germany, Russia, Norway, Sweden, the United States, Japan, and Mexico.

During 1913 more than half the world's production came from Australia, mostly from Queensland. The report of the Queensland Secretary for Mines for 1912 states that the output of molybdenite in that year was 102 tons 6 cwt., value £17,349, as compared with 99 tons 10 cwt., value £13,278, in 1911. The Larkin mine, the property of the Irvinebank company, maintained a monthly output of 1½ tons of molybdenite. Molybdenite was also obtained in the vicinity of Ollera creek, in the Townsville mineral district, to the amount of 17 cwt., value £143. The output of molybdenite in Queensland in 1913 is given as 57 tons 2 cwt., value £16,185.

Most of the molybdenite produced in New South Wales is obtained from the Whipstick mines, in the Pambula division, from which 73 tons of ore, valued at £6400, was raised in 1913. The annual report of the Department of Mines for 1913 states that the total quantity of molybdenite exported in 1913 was 78 tons 16 cwt., valued at £6802, as compared with 56 tons 11 cwt., valued at £3706 in 1912. In the Deepwater division, the Bow Creek molybdenite mines raised 70 tons of crude ore, valued at £1000.

Molybdenite has also been found in South Australia, Western Australia, and Tasmania. An occurrence of molybdenite was recorded in New Zealand in 1905 on the lower slopes of the Paparoa range, near Greymouth; but the deposit does not seem to have been worked.

Numerous occurrences of molybdenite in Canada and Newfoundland have been recorded but very little has been produced. In 1913, there was some prospecting activity in Ontario, Quebec, and British Columbia. It is reported that a mine in British Columbia despatched a carload of high-grade material for milling in Denver, and that a small trial shipment of the Ontario ore was made to England.

Deposits of molybdenite occur in Ceylon at Hettimulla, four miles south of Kasgalla. A sample examined at the Imperial Institute in 1906 contained nearly 51% of molybdenum, but according to the Progress Report of the Ceylon Mineral Survey the molybdenite-bearing pegmatite deposit was neither extensive nor rich in the mineral.

In the Federated Malay States molybdenite was observed by the Government Geologist in 1905 in a granite quarry near Bukit Panjang.

There is no record of molybdenite having been worked in India. It has been observed in small quantity in the Patra river, near Mahabagh, and the Baraganda copper mine at Urmi, near Dumri, Hazaribagh district, Bengal; in parts of Chota Nagpur; in Rajputana and Mandaoria, near Kishangarh; and in Burma, on the road from Tavoy to Myitta. Molybdenite also occurs disseminated through the Travancore pyrrhotites and might possibly be worth separating from the ores should these ever be worked for copper and nickel.

Outcrops showing molybdenite ore occur at Impendhle, at the foot of the Mahotoya range, Hlatimba river, Natal. A sample of ore from the Bushveldt district, Transvaal, examined at the Imperial Institute in 1906, contained molybdenite.

In the British Isles, molybdenite has been found in the Cornish copper and tin mines, but usually not in paying quantities. It is stated to have been worked in Inverness-shire. It occurs at the Mount Sorrel quarries of Charnwood Forest, Leicestershire, and is said to have been raised at Caldbeck Fell in Cumberland.

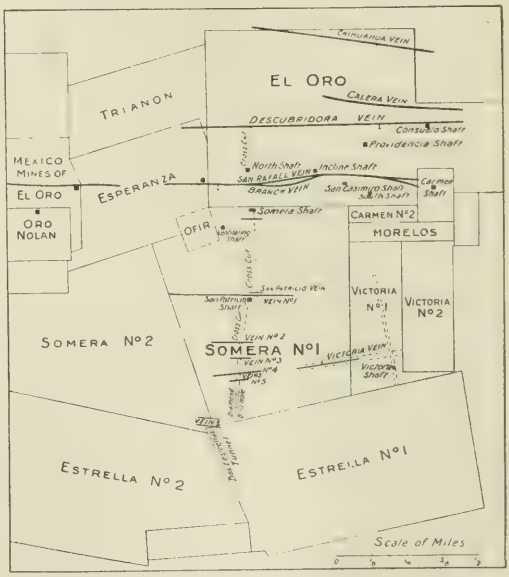
THE SAN RAFAEL VEIN AT EL ORO

The distribution of ore in the vein-matter here is notably irregular and permits of formulating no law that can be recognized throughout the mine.

By FERGUS L. ALLAN AND H. W. FAULKNER.

INTRODUCTORY.—The San Rafael vein at El Oro, Mexico, exhibits some unusual features of ore occurrence. It is worked by several companies, the El Oro Mining and Railway, Esperanza, and Mexico Mines of El Oro. The last named owns the most northerly of the important mines on this vein, and the characteristics of the vein have been specially studied by us at this mine. The vein is of the fissure type, and the width varies from 20 to 200 ft. The vein-matter consists of crystalline quartz. In places the quartz is banded, and it occurs either massive and hard or much fractured. In the upper levels there is enough iron as oxide to stain the quartz. In the lower levels, in addition to the oxide, the iron is also found as sulphide, although it can hardly be said that any definite sulphide zone has yet been reached in the main vein. In the western branch-veins, the iron exists almost entirely as sulphide. The gold everywhere is free, and is so finely disseminated as to be invisible to the naked eye. The silver occurs mainly as argentite, although some proustite is found. Some native silver ('wire' silver) has also been found in conjunction with the ruby silver in a limited part of the vein on the eighth level. The proportion of gold to silver varies considerably in different parts of the vein, the ratio in the upper levels being about 1 to 12, except near the capping, where the proportion of silver increases and the ratio reaches 1 to 30. At other places in the mine there is also a great variation in the ratio, as will be explained later. The average assay-value in the upper levels of the orebody in the main vein is between 6 and 7 dwt. gold and 4 to 5 oz. silver; many of the branch veins both in the upper and lower levels are much higher in content, and the proportion of gold to silver varies greatly.

The strike of the vein is approximately N 26° W in the Mexico mine, and the vein is approximately parallel to the other veins in the district, including the Dos Estrellas system. The San Rafael and Dos Estrellas veins are on the different sides of the same mountain ridge. The dip is from 55° to 75° to the west. The hill into which the San Rafael dips is composed of an andesite lava. This forms a capping, 600 ft. thick in the Mexico mine, lying on the surface that existed at the time of the volcanic outburst, sometime in the Tertiary age. The country throughout the entire district as far as explored at present consists of shale, containing in many places and especially near the vein, numerous seams



SKETCH MAP OF THE PROPERTIES OF THE COMPANIES WORKING AT EL ORO.

and layers of calcite. This shale has been determined by Government geologists and others to be of Lower Cretaceous age. No trace of any fossils has as yet been discovered. Development has not yet been carried to a sufficient depth to determine the rock underlying the shale in this district.

In many parts of the mine are found dikes, tongues, and large intrusions of andesite. The north shaft passed for 200 ft. through a body of andesite below that of the capping and of different age. The south shaft also, after passing through 400 ft. of shale below the capping, was in andesite for the next 400 ft., shale still being found between the andesite and the

vein, and then the shaft again passed into the shale. On the ninth level, an andesite dike has faulted a narrow hanging-wall vein two or three feet. The centre of these disturbances has not yet been discovered.

It is not, however, so much intended to describe the geology of the district in detail, as to set forth the manner of the ore occurrence. In the latter respect the San Rafael vein is as full of surprises as it is of mineral wealth. A statement can often be made with regard to one part of the mine, only to be contradicted with regard to another; a theory may be put forward to account for an occurrence in one part, only to fail when applied to another; and this without any obvious explanation. This uncertainty of what is to be expected makes the development of these properties difficult and expensive.

BARRENNESS AT DEPTH.—The notable feature of the vein, seen throughout its entire length as at present worked, is the abruptness of the termination of profitable ore in depth, and the well-defined boundary between the ore and the barren ground below. In the southern portion of the vein, the barren rock is reached at a less distance from the present surface than in the northern portion, owing to the vertical displacement caused by the numerous faults. Mr. J. E. Spurr, who ex-

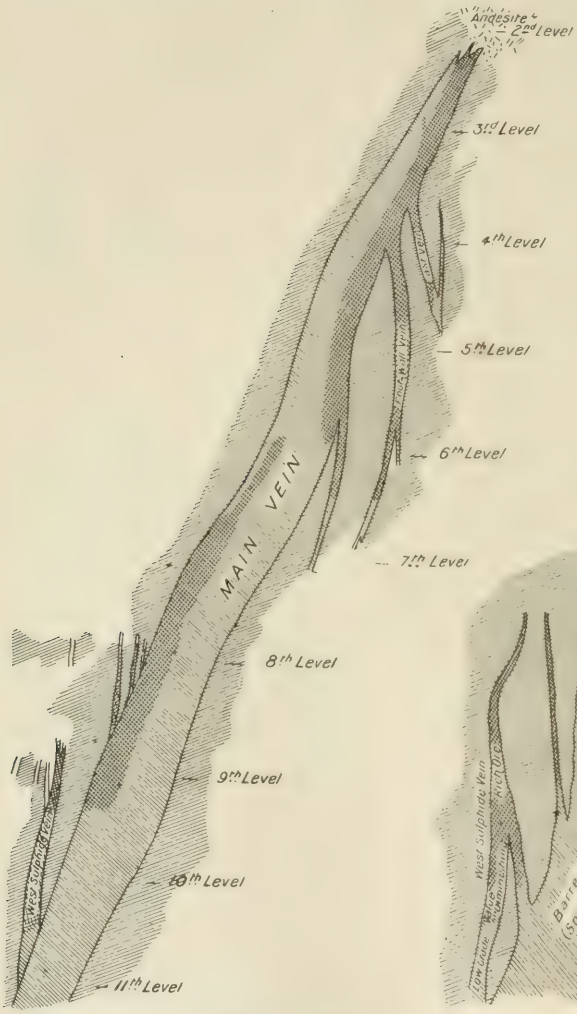


FIG. 1. SECTION 900 FT. NORTH OF SOUTHERN BOUNDARY.

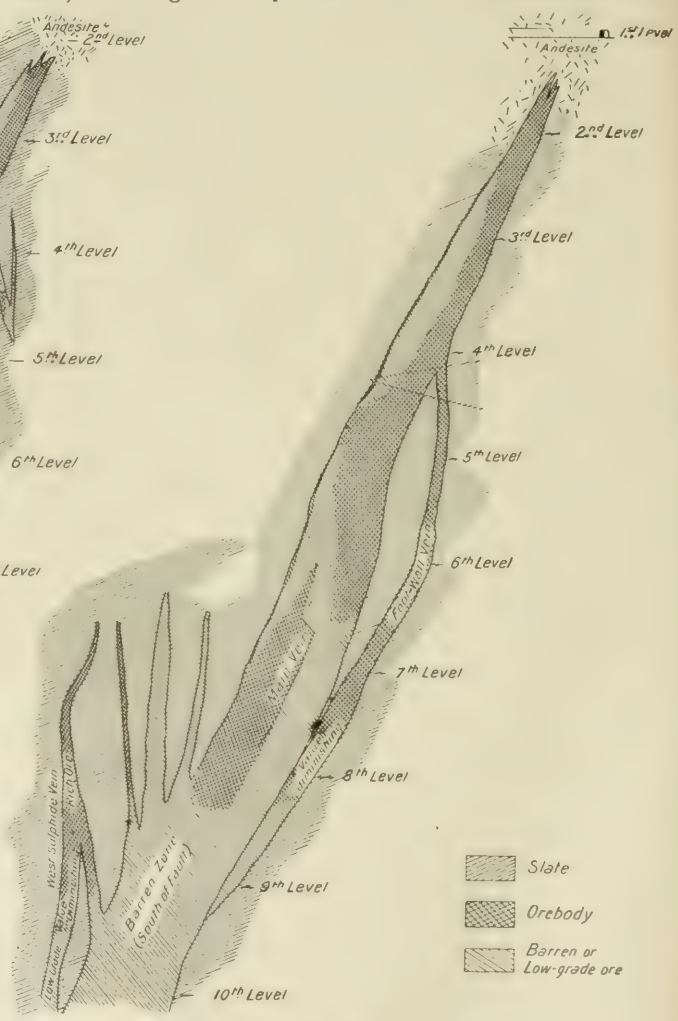


FIG. 2. SECTION 500 FT. NORTH OF SOUTHERN BOUNDARY.

The sections illustrate the position of the branch veins, especially of the West Sulphide vein; also the fact that the main and branch veins show no enrichment at the junctions.

amined the fault system in the Esperanza mine, has stated that the sum of the vertical displacements in that mine has amounted to 1000 feet.

In the Mexico mine it would appear that we are now reaching the barren rock at a depth of approximately 1650 ft. below the surface, or 1000 ft. below the capping, which is roughly the depth at which it should be found as indicated by Spurr's investigations.

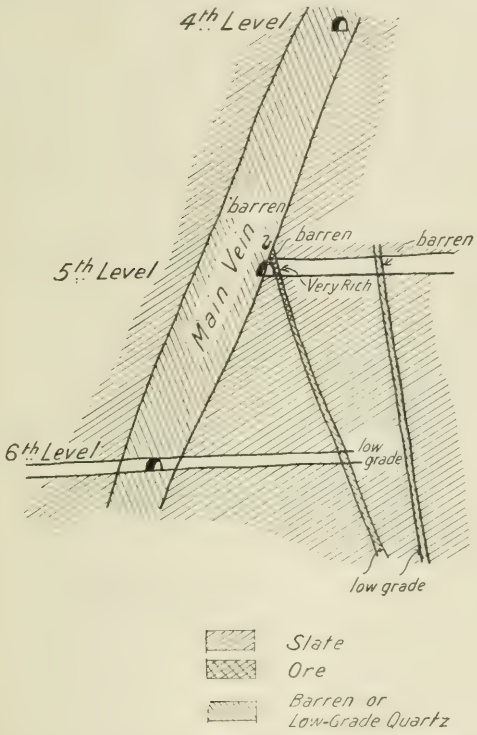


FIG. 3. SECTION 1500 FT. NORTH OF SOUTHERN BOUNDARY.
On the 5th level at this point, the main vein is barren, and the branch vein also barren at the junction of the two, but a few feet below the junction the branch vein contains very rich ore.

But at the horizon at which the main vein appears to have reached the limit of profitableness in depth, the situation is saved by the fact that various branch veins are being found, the richness of which compensates for the exhaustion of the main vein. At this depth the main vein is about 60 ft. wide and, though mineralized, is unprofitable to work.

Many of the numerous veins that have been worked have in the past been considered as being separate veins. But all the evidence so far disclosed tends to show that they are feeders from the main vein. At the point of divergence no increase is found in the mineral contents of the main vein. If at the junction the main vein is poor in mineral contents, the feeder as it approaches the junction also becomes poor. If the main vein is rich at the point of junction no noticeable increase in content takes place. (See Figs. 1, 2, and 3.) This is not in accordance with the usual experience that an enrichment is to be expected at the junction of a feeder with the main portion of the vein, or at the junction of two separate veins. One of the most important of these branch veins or feeders is the West Sulphide vein. (See Figs. 1 and 2.)

WEST SULPHIDE VEIN. — This vein, so called because it contains much iron sulphide, although still containing oxide of iron to a considerable extent, is a continuation of the famous Esperanza West vein. The top of the vein is found in the Mexico mine at the sixth level, 1150 ft. below the surface, or 550 ft. below the capping. The top of the vein pitches downward toward the seventh level until it meets a fault. North of the fault it is not again found until the ninth and tenth levels are reached, where a rich orebody is now being developed, which, though it is not yet entirely proved, can hardly be anything else than the continuation to the north of the West Sulphide vein, after the latter has been displaced vertically by 200 ft.

On the tenth level, farther north than any ore yet found on the levels above, this vein and subsidiary branches are continuing to provide ore as good as any yet found in the mine. At no great distance below this level, the branch must join the main vein where the latter is barren. It has already done so at some points south of the fault, and apparently also at other points north of the fault. Where this has occurred, the rich ore has decreased in amount or almost disappeared. (See Fig. 1.) Development at the northern end of the mine, however, is tending to prove that the pitch of the orebody in this vein is to the north, as rich ore is still being found several hundred feet farther north on the tenth level than on the level above. Also, the strike of the vein in this northern region is diverging sharply from that of the main vein, so that a junction should not take place until considerably greater depth is attained than is the case farther south. A promising opportunity for development is therefore presented. An interesting point is whether future development will show that this exception to the general rule, namely, an impoverishment at a junction, continues to hold good.

Another interesting point is based on the question as to the determining cause of the great richness of this vein at a point only a

few feet above the low-grade point of junction with the main body. The theory might here be put forward that the comparative narrowness of this feeder has enabled the enclosing rock to act more efficiently and selectively as a precipitant. (See Figs. 1 and 2.) But against this is the fact that within a very short distance other subsidiary feeders, apparently similar in all respects, except as to quantity of valuable content, are to be found, to which the theory does not apply. (See Fig. 1.)

Again in the upper levels, between 400 and 600 ft. above the horizon mentioned, the main orebody attains a width of 60 ft., the whole of which consists of rich ore, the feeders at this point giving in some cases high assays and in others being barren or unprofitable.

No faulting that could have in any way affected the deposition of ore is to be found in either of these conflicting cases. In fact, the faulting in any part of the mine where it occurs has apparently no definite bearing on the ore deposition. In some cases ore is found right up to the fault and on either side of it, and in others the ore rapidly diminishes as the fault is approached, both these conditions being found even in the case of the same fault at different horizons.

Perhaps, however, the second objection raised against the theory mentioned is not a case in point. For it may be possible that the main vein in its original state was mineralized only to a small extent, and that a great amount of erosion has taken place, with a consequent concentration of the minerals due to their re-solution and re-precipitation at lower levels; and that the somewhat abrupt transition from the ore-bearing portion of the vein to the barren rock below is due to the sudden cessation of this process owing to the outflow of lava, which covered the surface and protected it from the influence of atmospheric and surface agencies.

EAST VEIN.—From the middle toward the north end of the mine, there is another feeder called the East vein, which branches from the main vein on its foot-wall side between the third and fourth levels (that is, about 150 ft. below the top of the vein at this point) and continues downward, dipping east at about 80°. It differs from the feeders so far found in the hanging-wall side of the vein lower down, in that after reaching a depth of about 100 ft. from where it branches off, it becomes narrower and diminishes, until at the fifth level there is little of it to be found, and when found it is worthless. Where it leaves the main vein it is rich in gold and silver, as is also the main vein at this point; but as it descends, the gold and silver decrease in quantity till it becomes practically barren. (See Fig. 1.)

THE FOOT-WALL VEIN (see Figs. 1 and

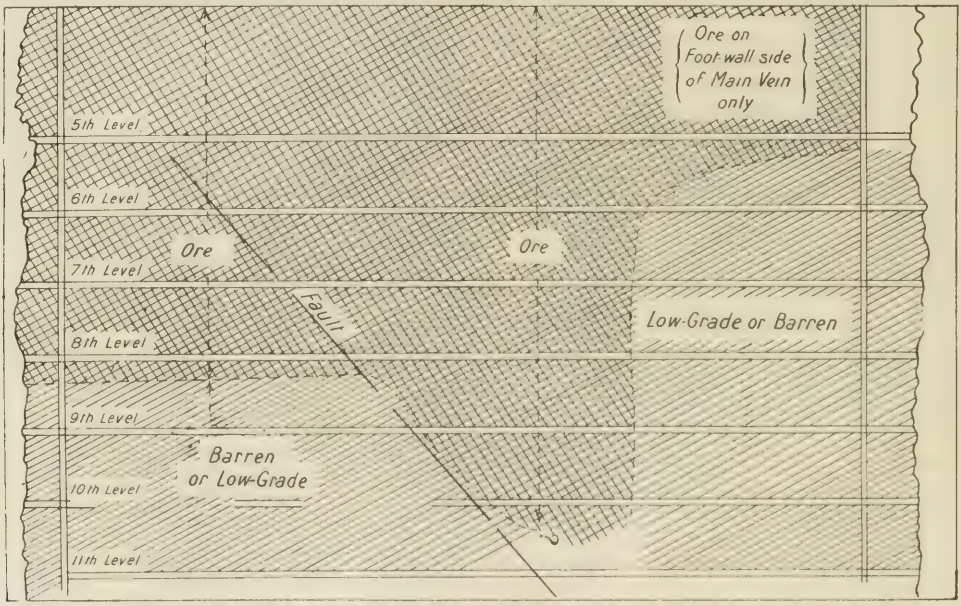


FIG. 4. SKETCH ILLUSTRATING HORIZONTAL LINE OF ORE LIMIT OF MAIN VEIN, IN DEPTH, BELOW 8TH LEVEL AND EXTENSION OF ORE TO NORTH OF FAULT.

The lower limit of the main orebody is well defined. In places faulting has carried the orebody to lower levels.

2) is another subsidiary vein, and it differs from the others mentioned, in that it joins with the main vein at its northern and southern extremities throughout its entire vertical extent, embracing between the points of junction a large horse of shale. Parts of this vein are extremely rich, often assaying 200 to 300 dwt. gold and 100 to 200 oz. silver per ton. Much of the shale in proximity to the vein also contains enough metal to make it worth mining. Sometimes it is as rich as the vein. This fact is due to the presence of narrow stringers of quartz often $\frac{1}{4}$ in. or less wide, which must be abnormally rich.

ORE IN THE MAIN VEIN.—The occurrence of ore in the main vein itself also presents some interesting features. From the top of the vein to the sixth level (that is, for a distance of 600 ft. downward) the ore occurs mainly in the foot-wall portion of the vein, the width of the orebody varying from 10 to 60 ft. In one part of the fifth and sixth levels the entire width of the vein is highly mineralized. From this level downward, a change takes place, and the ore is found on the hanging-wall portion of the vein. (See Figs. 1 and 2). The change from foot to hanging is marked by an increased proportion of silver, though a ratio more nearly approximating the normal is attained with increase in depth. In connection with this feature, it should be noted that in the upper levels, where the ore is found on the foot-wall side, the feeders also are invariably to be found in the foot-wall, and lower down, where the ore is on the hanging-wall side, so also are the feeders. Moreover, the foot-wall branches from the upper part of the vein extend downward and disappear in depth, while the hanging-wall branches extend upward and disappear above.

We stated earlier in the article that the transition from the ore-bearing portion of the vein to the barren rock below is abrupt. This is more especially noticeable in the southern portion of the mine, south of the main fault. Here the ore extends 40 ft. below the eighth level and then terminates in an approximately horizontal line. (See Fig. 4).

North of the fault the orebody is found for about 400 ft., but on the levels below the eighth it disappears along the fault-plane. If therefore, in view of the abrupt and approximately horizontal termination of the ore below the eighth level, an estimate of the ore available were to be made on the assumption of an extension in depth proportionate to the horizontal extension, a serious error would have arisen. Considerations of this nature have necessarily enforced the policy of including in any estimate of ore reserves practically nothing beyond what has been definitely proved.

Although we are aware of the indefiniteness of many of the conclusions suggested, and the objections to which the tentative explanations of some of the peculiarities of this vein are open, it is hoped that the various features we have attempted to describe will be found worthy of the notice of those interested in the study of ore deposits.

Cost of Stamp-Mill Construction.

The cost of erecting mining and metallurgical plant in various parts of the world is a subject too little discussed. The following information relating to the cost of constructing a stamp-mill in Colombia, South America, sent by Mr. A. E. Drucker, is therefore welcome.

The Frontino & Bolivia Gold Mining Co. Ltd. has recently completed a 10-stamp mill, as an addition to the existing plant at the Maria Dama mine, which is situated about three miles from Remedios. The machinery was purchased from Fraser & Chalmers Ltd. and shipped from London to Puerto Colombia, thence by rail 17 miles to Barranquilla, by river steamer 300 miles to Zaragoza, and finally by mule transportation 40 miles to Maria Dama. The total weight of machinery was 34·3 tons. The costs are given in the following tables, being segregated under transportation, construction, and plant.

TRANSPORTATION COSTS.

London to Puerto Colombia	£79	3	0
Puerto Colombia to Zaragoza	65	5	0
Zaragoza to Maria Dama	247	12	0
Road Repairs	67	18	0
Total		£ 459	18 0

CONSTRUCTION COSTS.

Excavations, drainage, retaining walls	£765	2	0
Concrete mortar-blocks	711	18	0
Ore bin and foundations	536	0	0
10-stamp battery-frame complete	409	13	0
Mill buildings (wood and sheet-iron roof)	368	4	0
Grizzly, crusher, and shafting	132	11	0
Total		£2923	8 0

MACHINERY F.O.B. LONDON.

Ten 1050-lb. stamps, mortars, feeders, belt-tighteners, copper amalgamating plates	£625	0	0
Grand Total		£4008	6 0

While referring to this extension of plant for the Frontino & Bolivia company, it is of interest to add that a slime plant is being erected, on the Dorr counter-current system.

DISCUSSION

Tin-Dressing in Bolivia.

The Editor:

Sir—Permit me to reply to Mr. R. T. Hancock's letter in your issue of January last. It is difficult to understand why, after asserting that he is ignorant of conditions obtaining in Bolivia, he concludes his letter with the imputation that operators are giving tin away. For Mr. Hancock's information I may state that the greater part of Bolivian tin concentrate contains a large percentage of limonite with a specific gravity of about 4. I recently had some investigations made in London as to the feasibility of removing this limonite from the concentrate, magnetically, with the result that a preliminary roast was found necessary and even thereafter the tailing was very rich in tin. It may be that later some kind of electrostatic separator will become available, but in the meantime, as the price of fuel is prohibitive in Bolivia, it would appear that magnetic separation is not economically applicable on oxide ore of this class. Where sulphide ores are roasted the case is different.

To give point to the above remarks I give in Table I the analyses of some lots of Bolivian concentrate amounting to nearly 140 tons. These analyses were made in London, and the tin assays reported were used as the basis on which these lots were sold. The ratio of concentration was over 40 to 1. Mr. Hancock will agree that concentrate containing only 4% silica is clean so far as mechanical tin-dressing goes. Taking therefore the proportion of silica present as a rough standard of comparison, it will be noted that almost the most 'dirty' of all the lots on the list is the one with the highest tin-assay. The one with the lowest tin-assay contained only 3·8% silica.

TABLE I. SOME ANALYSES OF BOLIVIAN TIN CONCENTRATE.

Cassiterite		Oxide of Iron	Cassiterite and Oxide of Iron together	Silica	Copper	Antimony	Sulphur	Total
Sn. %	O_2 %	%	%	%	%	%	%	%
66·0	18·2	11·5	95·7	4·6	0·0	Tr.	Tr.	100·3
64·5	17·8	12·5	94·8	4·0	0·0	0·3	0·5	99·6
64·4	17·8	12·7	94·9	3·9	0·0	Tr.	Tr.	98·8
63·65	17·6	14·0	95·2	4·1	Tr.	Tr.	Tr.	99·3
62·35	17·2	15·0	94·5	3·9	Tr.	0·2	Tr.	98·6
62·2	17·2	15·3	94·7	4·3	0·0	Tr.	1·0	100·0
62·15	17·1	15·5	94·7	4·2	0·0	Tr.	1·0	99·9
62·06	17·1	15·4	94·6	4·0	Tr.	0·3	Tr.	98·9
61·4	16·9	16·4	94·7	3·2	0·0	Tr.	1·0	98·9
61·2	16·9	18·1	96·2	3·7	Tr.	Tr.	Tr.	99·9
61·0	16·8	17·0	94·8	4·4	0·0	0·4	Tr.	99·6
60·75	16·8	15·5	93·0	4·7	Tr.	Tr.	1·0	98·7
60·7	16·7	17·0	94·4	3·7	Tr.	Tr.	1·0	99·1
60·45	16·7	17·5	94·6	3·7	Tr.	Tr.	1·0	99·3
60·35	16·6	17·0	93·9	4·5	Tr.	Tr.	Tr.	98·4
60·2	16·6	18·0	94·8	4·0	Tr.	Tr.	1·0	99·8
60·2	16·6	18·0	94·8	3·8	Tr.	0·2	0·35	99·1

Referring again to the analyses, it will be remarked that the percentage of cassiterite and oxide of iron taken together varies between 93·0% and 96·2% of the whole.

It is thus clear that the degree to which it is economically desirable to clean a Bolivian, or any other, tin ore depends entirely on its nature.

To conclude my remarks, and in the hope that they will be useful to Mr. Hancock, I add in Table II the results of a test made for me on this subject by Mr. Charles Lacy

Price in September last. It will be noted that Mr. Price has taken a less figure than £36 for the realization charges, but even substituting £36, the result, though modified, is the same. It was found that the residue, although carrying a considerable amount of tin, was so difficult of further treatment as to be practically valueless. It was therefore definitely proved that it did not pay to remove from this 59·4 % tin concentrate a product assaying about 31 % tin; which result is the exact opposite of that arrived at by Mr. Hancock using arithmetic alone.

TABLE II. BARRILLA RE-WASHING TEST.

30 Quintals concentrate assaying 59·4 % tin were re-washed with the result that 22 qs. concentrate assaying 69·4 % tin was produced.

The following was the extra cost involved in re-washing :

		Bolivian Dollars
1st day	Concentrator	3·50
	2 Girls	1·80
	¼ Samples	0·45
2nd day	Concentrator	3·50
	2 Girls	1·80
	Samples	1·80
	Total	12·85
	With B's at 18d. =	£0·965

Comparative Estimates on Base of Sales Contract.

Tin £150 — Assay 59·4% ..... £89·100

Deduct 4·15 units ...	6·225	£30·725
Deduct ret. charges.	6·500	
Deduct all other charges at mine till sold	18·000	
		£58·375

Multiplying by number of tons = 1·382 (30 qs.) gives the total net value of lot £80·674

Assay 69·4% ..... £104·100

Deduct 2·65 units	3·975	£28·475
Deduct ret. charge	6·500	
Deduct all other charges at mine till sold.....	18·000	
		£75·625

Multiply by number of tons = (22 qs.) 1·01 tons ..... £76·381

Deduct extra buddling charge B. 12·85 at 18d. ..... 0·965

Total net value of lot £75·416

Note: 21·7 Spanish Quintals were taken as being equal to one long ton; a few ounces of good weight always being given in weighing.

HAROLD ALLMAN LEWIS.

Potosi, March 11.

Statistics of Transvaal Gold Production.

The Editor :

Sir — In an editorial note in your last month's issue, with reference to the Transvaal Chamber of Mines' monthly statistics of production, working cost, and working profit on the Rand, you ask for an explanation "in connection with the figures for the yield, cost, and profit per ton milled. Presumably," you add, "the sum of the figures for the cost and profit should be equal to the yield, but in many cases they fail to check."

May I, in reply to your question, refer you to the explanatory note on this point attached to the monthly statistics, which reads: "For various reasons the working profit shown is not in all cases the exact difference between the yield as shown and the working costs as shown. Thus, while the gold recovered from accumulated slimes is included in the yield, the profit therefrom sometimes appears in sundry revenue instead of in working profit. Again, while the yield is valued at a fixed rate per fine ounce, the rate applicable to the working profit is the actual realizable value of gold, which fluctuates slightly."

A. R. GOLDRING.

Transvaal Chamber of Mines,
London Office, April 23.

The Mining of Alluvial Deposits.

The Editor :

Sir—The article entitled 'The Mining of Alluvial Deposits,' by Newton B. Knox and Charles S. Haley, appearing as a serial in the Magazine, contains several matters to which I would like to take exception, as my experience differs from that of the authors in these and other respects.

The authors speak of sampling in bulk as being the former practice in California, though this was rarely followed except by so-called practical men and Chinamen, and then only when considering a very small property. While the practice properly meets with the authors' disfavour, they immediately afterward advocate the use of a small dredge for testing dredging-ground, saying "where funds are available this method gives most satisfactory results." This has been a practice greatly encouraged by dredge-builders, but the results obtained by such a sampling-dredge, apart from giving some knowledge of the physical conditions, would merely indicate the mineral content of the material washed, regardless of whether this had been previously enriched by nature only, or if nature had been assisted in this respect. The results might have little

bearing on the content of the rest of the property.

The percentage of recovery made by a dredge of the amount indicated in prospecting is, as Mr. Pickwick would say, "in itself a question of no inconsiderable magnitude." It has been possible for me in my professional work to obtain many figures on this phase of gold-dredging, and while I do not wish to go into this subject extensively at this time, I should like to take exception to the statement of recovery made by dredges in Alaska. The fact that "the dredging depth has exceeded the drilled depth in cases by as much as 30 to 40%" should be sufficient to vitiate any figures of comparison. The recovery actually made by Alaskan dredges has in nearly every case been considerably under the estimated gold content of the ground, and a large number of the dredges have been economic failures. In some cases the ground was first prospected with drills, in others the dredge was used to prospect the property.

In another part of the paper the statement is made that "we would not consider any alluvial ground properly and finally tested without the sinking of at least a few shafts." This must be considered an individual opinion; one not generally shared by placer engineers and operators. While sampling from shafts, when feasible, is preferable to drill sampling, drilling methods have so far advanced that results obtained from each hole, when the work has been properly performed, can be regarded as representative of that section. The placing of either drill-holes or shafts is of vital importance. The content as indicated by a single drill-hole carries little weight as an evidence of the average content of the whole property; it is only from the results obtained from a number of holes intelligently placed and properly sampled that a correct estimate can be made of the mineral content.

The recovery of gold by dredges from some of the land first worked in California that had been valued according to methods of drilling then followed was only a small percentage of the gold content previously estimated, but recovery by dredges following modern methods of drilling is more nearly in accord with prospecting results.

Other conditions being favourable, those connected with the largest dredge operations in the world would not hesitate to finance a dredging property, the mineral content of which was based entirely upon drilling tests made by engineers in whom they had confidence.

The authors' description of tests they made with the Banka type hand-drill are interesting and I may desire to discuss this part of the paper at another time. The failure in Siberia to "find any gold whatever" from a series of drill-holes sunk between shafts that "had given results of 20 cents to $1·20 per cu. yd." is unusual, and I hope that results from the further testing mentioned by the authors will be available.

My experience with the so-called Alaskan hand-drill was not such as would induce me to become an advocate of this method of sampling, though under certain conditions this drill also can be used to advantage.

CHARLES JANIN.

San Francisco, April 10.

Persistence of Ore in Depth.

The Editor:

Sir — Too much water has flowed under London Bridge since T. A. Rickard's contribution to the Transactions of the Institution of Mining and Metallurgy on the 'Persistence of Ore in Depth' to permit of my participation in the discussion. His paper, however, with which I am in hearty accord, as well as the discussion, with parts of which I emphatically disagree, suggest certain side issues which may be raised even at this late date.

Mention has been made of the difficulty in estimating the amount of degradation to which a given orebody has been subjected since deposition, and, indeed, those cases must be rare in which even a rough approximation can be reached. A certain idea may be gained by considering the minimum amount of erosion necessary to enrich a copper deposit to a given degree, but this implies access to the primary zone, and the certainty that it is primary, an assurance not always obtainable even by the most refined methods. Once, at least, it was my good fortune to encounter the ideal conditions. From a copper-bearing pyritic orebody, a lode extended outward and upward into the wall in such form as to be protected by the overlying rock from contact with downward-circulating currents. A comparison of the undoubtedly primary ore of the lode with the enriched ore of the main lode supplied the basis for a rough computation of the minimum amount of degradation that the orebody had undergone, and proved its deep-seated origin. It is much to my regret that I am not at liberty to give the details of this interesting occurrence, but its form is illustrated by the familiar cross-section of the Rammelsberg deposit.

If engineers would record all their observations of phenomena indicative of the depth of

ore deposition, however wide of precision the results might be, they would, in my belief, be contributing toward conclusions of great ultimate value. How irksome does the examining engineer, in concluding his report, find the self-restraint of omitting from his estimates any ore lying below the lowest mine working, confining himself to a few vague remarks about the "excellent prospects for persistence in depth." He may know the ore is there, but he cannot prove it. The dream may not be fanciful that another generation of mine reports may reasonably include such assertions as: "Ore of this grade may be relied upon to extend in depth 1500 ft. further." If we are to judge of a man's stature through a crack in the fence, it is important to know whether we are contemplating his boots, his hat, or his waistcoat; hence a principal element of the problem will be the determination of the position in its original vertical extent of that part of the deposit exposed to study.

The foundations for a classification of ore deposits according to relative depth have already been laid by such men as Waldemar Lindgren and J. E. Spurr, and it may well be that along such lines will lie the next great advance in economic geology.

Mr. Rickard's paper has induced certain references to the invalidity of drilling results as a basis for the computation of metal contents, and so common have such utterances become as to make it appear that a laudable caution is in danger of crystallizing into a time-honoured superstition. While admitting that bore-holes may give reliable information on the extent and volume of an orebody, it is not uncommonly denied that the assays of the cores or drillings may be used as conclusive data.

In denial of these objections, I am prepared to assert that in special cases the drill is a more reliable sampler than the hammer and moil. If the flotation of every new enterprise were condemned by professional conservatism or prejudice to await the development of the orebody by mining methods, it is safe to say that some of the most valuable sulphide deposits of Asia and Australia, as well as the 'porphyries' of America would never have been heard of. In these cases, the close correspondence between the bore-hole assays and those derived from subsequent mining operations has been such as to fully vindicate the former. As a matter of fact, every deposit is a special case and should be treated as such, but, in so far as a rule can be formulated at all, it may be said that where the ore is of such texture as to yield a high percentage of core, where the orebody is continuous and the assay-values not too diverse, a sufficient number of bore-holes may be relied upon to represent the value of the deposit as a whole. Where, on the other hand, the lode is discontinuous, the metal content pockety, and the ore physically unfavourable, the diamond-drill should be banished from the property as an instrument too dangerous even for storage in the powder-magazine.

H. H. KNOX.

New York, April 10.

Dip of Drill-holes.

The Editor:

Sir—At many mines where diamond-drilling is in progress, it is usual to ascertain the dip of the hole by lowering glass tubes an inch or less in diameter partly filled with hydrofluoric acid. The section of the hole is then plotted direct from the etched tube. This is entirely inaccurate, as, owing chiefly to the effects of surface-tension, the angle plotted from the tube is greater than the actual dip of the hole. I recently made some tests with tubes $\frac{7}{8}$ in. in diameter and found that the error on dips varying from 45° to 65° from the horizontal was frequently as much as 10°. With smaller tubes the difference was even greater. The inference is that the majority of holes that are surveyed and plotted by this method are really shallower than is supposed. When estimating the quantity of ore by bore-hole results, this error may lead to considerable over-estimation. By filling the tube with liquid having the same specific gravity as the acid, so that the surface of the liquid coincides with or is parallel to the etching and then measuring the angle between this surface and the tube, it is possible to get within a degree or two of the true dip. To further reduce error it is advisable to use tubes of as large a diameter and of as thin glass as possible.

E. C. BLOOMFIELD.

Zyrianovsk, Siberia, March 7.

[We appreciate the point made by our correspondent, but some qualification must be made in respect of his suggestion that the tube should be filled, above the hydrofluoric acid solution, with a liquid of the same specific gravity. This liquid, if of the same specific gravity, must be of such a nature as to be not attacked by the lower liquid and not miscible with it. But the specific gravity should be appreciably less than that of the hydrofluoric acid solution.—EDITOR].

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	April 1 1915	May 3 1915
RAND:			
Bantjes	14	11	10
Brakpan	51	51	52
Central Mining (£12)	160	122	137
Cinderella	6	4	4
City & Suburban (£4)	52	49	47
City Deep	66	58	64
Consolidated Gold Fields	43	29	32
Consolidated Langlaagte	35	34	36
Consolidated Main Reef	18	18	19
Crown Mines (10s.)	120	85	94
Durban Roodepoort	21	21	21
D. Roodepoort Deep	17	15	17
East Rand Proprietary	33	34	32
Ferreira Deep	47	45	50
Geduld	23	24	27
Geldenhuis Deep	26	22	22
Heriot	55	61	62
Jupiter	5	5	7
Kleinfontein	24	24	26
Knight Central	8	6	5
Knight's Deep	35	21	21
Langlaagte Estates	20	18	18
Luipaard's Vlei	10	7	8
Main Reef West	7	8	8
Meyer & Charlton	115	102	107
Modderfontein B	89	93	96
Modderfontein, New (£4)	263	269	289
Nourse	27	22	23
Primrose	21	13	14
Rand Mines (5s.)	120	94	100
Randfontein Central	17	13	14
Robinson (£5)	57	36	35
Robinson Deep	33	26	26
Rose Deep	43	36	36
Simmer & Jack	12	9	8
Simmer Deep	1	1	1
Springs	11	20	24
Van Ryn	67	59	61
Van Ryn Deep	47	46	51
Village Deep	40	36	38
Village Main Reef	40	31	31
Witwatersrand (Knight's)	71	59	62
Witwatersrand Deep	48	39	35
Wolhuter	14	13	13
RHODESIA:			
Cam & Motor	19	15	15
Chartered	17	12	12
Eileen Alannah	11	9	9
Eldorado	18	15	15
Enterprise	9	5	6
Falcon	14	11	11
Giant	14	8	8
Globe & Phœnix (5s.)	32	30	31
Lonely Reef	27	24	22
Shamva	46	37	37
Wanderer (5s.)	3	3	1
Willoughby's (10s.)	7	6	6
OTHERS IN SOUTH AFRICA:			
De Beers (£2 10s.)	330	240	237
Glynn's Lydenburg	11	10	10
Jagersfontein	78	60	62
Premier Diamond (2s. 6d.)	152	102	100
Sheba (5s.)	4	4	4
Transvaal Gold Mining Estates	37	37	39
WEST AFRICA:			
Abbontiakoon (10s.)	8	9	9
Abosso	14	9	9
Ashanti (4s.)	16	15	16
Broomassie (10s.)	2	2	2
Prestea Block A	15	12	13
Taquah	15	15	15
WEST AUSTRALIA:			
Associated Gold Mines	7	5	5
Associated Northern Blocks	7	5	5
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	50	49
Great Boulder Proprietary (2s.)	14	16	15
Great Boulder Perseverance	2	2	2
Great Fingall	9	7	6
Ivanhoe (£5)	50	59	45
Kalgurli	36	37	34
Sons of Gwalia	23	19	15
Yuanmi	3	2	2

	July 1 1914	April 1 1915	May 3 1915
OTHERS IN AUSTRALASIA:			
Blackwater	16	15	12
Consolidated Gold Fields of N.Z.	13	11	12
Mount Boppy	10	11	12
Mount Morgan	52	47	49
Progress	10	6	7
Talisman	33	27	24
Waihi	42	44	45
Waihi Grand Junction	25	25	25
AMERICA:			
Alaska Treadwell (£5)	162	145	146
Buena Tierra	15	13	13
Butters Salvador	20	10	10
Camp Bird	9	6	6
Canadian Mining	—	9	9
Casey Cobalt	13	8	12
El Oro	14	8	8
Esperanza	15	9	8
Granville	10	—	—
Kirkland Lake Proprietary	74	31	31
Mexico Mines of El Oro	97	75	79
Oroville Dredging	10	12	12
St. John del Rey	15	15	15
Santa Gertrudis	11	8	7
Tomboy	22	24	24
Tough-Oakes	28	14	14
RUSSIA:			
Lena Goldfields	43	36	39
Orsk Priority	7	—	9
Siberian Proprietary	3	4	6
INDIA:			
Champion Reef (2s. 6d.)	11	11	12
Mysore (10s.)	93	86	86
Nundydroog (10s.)	27	26	26
Ooregum (10s.)	23	27	25
COPPER:			
Anaconda (£5)	126	119	154
Cape Copper (£2)	60	55	62
Chillagoe (10s.)	1	½	½
Cordoba (5s.)	6	3	3
Great Cobar (£5)	3	1	2
Great Fitzroy (5s.)	½	¼	¼
Hampden Cloncurry	27	25	25
Kyshtim	55	53	53
Messina (5s.)	15	10	10
Mount Elliott (£5)	55	70	65
Mount Lyell	23	26	25
Rio Tinto (£5)	1355	1205	1240
Sissert	25	24	24
South American Copper (2s.)	22	13	14
Spassky	52	41	50
Tanalyk	78	54	52
Tanganyika	40	29	28
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	28	24	23
British Broken Hill	36	27	26
Broken Hill Proprietary (8s.)	36	41	43
Broken Hill Block 10 (£10)	32	26	24
Broken Hill Block 14 (25s.)	6	—	—
Broken Hill North	52	46	45
Broken Hill South	175	145	151
Sulphide Corporation (15s.)	26	19	20
Zinc Corporation (10s.)	19	15	14
ASIA:			
Burma Corporation	28	31	39
Irtysh Corporation	—	—	39
Russian Mining	31	22	21
Russo-Asiatic	151	106	110
TIN:			
NIGERIA:			
Bisichi	8	8	8
Jos (5s.)	5	5	5
Kaduna (5s.)	15	15	15
Naraguta	17	17	17
N. Nigeria Bauchi (10s.)	3	1	2
Rayfield	5	5	5
Ropp (4s.)	100	17*	17*
OTHER COUNTRIES:			
Aramayo Francke	31	27	27
Briseis	5	6	6
Cornwall Tailings	17	15	15
Dolcoath	11	8	9
Geevor (10s.)	5	4	5
Gopeng	27	29	36
Mawchi	20	4	2
Pahang Consolidated (5s.)	7	7	8
Renong Dredging	36	21	21
Tekka	55	60	60
Tronoh	26	32	31

* Denomination of shares recently changed from £1 to 4s.

PRECIS OF TECHNOLOGY

[*Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.*]

Antarctic Coal.—In our issue of July 1913, we gave a short account of the mineral discoveries made by Dr. Douglas Mawson during his expedition to the antarctic regions, more particularly mentioning the coal deposits found there. Dr. Mawson has since published his book of travel, 'The Land of the Blizzard.' Prompted by information contained in this book, Professor J. W. Gregory has written an article, published in the *Manchester Guardian* for February 3, discussing the existence of coal in ice-bound regions. We know also that coal is found among the glaciers of Alaska and in the island of Spitzbergen in the North Polar sea.

To quote Professor Gregory: The expedition has strengthened the impression left by the work of previous expeditions that coal is widely distributed in Antarctica. These discoveries raise a vision of that continent when it was covered by forests, before it had been buried under its present pall of ice. This fundamental change in the south polar climate may appear to demand a revolutionary change in the geographical conditions of the earth as a whole. Suggestions have, therefore, been renewed that the earth's axis of rotation was once shifted, so that the present poles passed into the warmer zones of the earth and other regions took their turn as the frozen polar wastes. Such a displacement of the poles, it has often been held, is mainly required to explain the removal of the polar regions from the long winter night; for it has been claimed that this prolonged darkness would absolutely prevent the growth of the coal-forming vegetation. The experience of the Petrograd conservatories, where the trees are kept in artificial darkness throughout the winter, shows that this argument is invalid. The case for former migrations of the poles rests, therefore, on its supposed necessity to account for a sufficient change of temperature to allow of luxuriant vegetation growing in the arctic and antarctic regions.

It should be remembered that the most unexpected fact in the distribution of coal on the earth is that it is not characteristic of the tropics. There is comparatively little coal in the tropical regions, and such coal as occurs there is of inferior quality. The main coalfields are in the temperate zones, while coal is already being worked commercially in Spitzbergen, in 78° North latitude, which is much farther from the equator than the coal discovered by Sir Douglas Mawson.

The theory that the pole has wandered to lower latitudes is a revival of the speculations of Alessandro in the fifteenth century. He adopted it to explain how such a tropical animal as the elephant could have once lived in Europe. The theory has been most strenuously opposed by the mathematicians. They reject it on the ground that the great equatorial bulge of the earth renders any appreciable displacement of the axis of rotation quite impossible. It is, however, conceivable that the earth, during shrinkage, may have altered its shape and once have been spherical; and, if so, a further change of shape might have led to a displacement of the axis around which the earth rotates.

The astronomers would probably be almost unanimous in dismissing this view; but it is, fortunately, unnecessary to rely on mathematical probabilities. The theory of the movements of the pole can be tested by reference to the actual geological facts as to the distribution of climate on the earth during those periods for which, at first sight, there is most to be said for the shifting of the poles. Thus, either at the time of the formation of the chief British coalfields or only a little later, glacial conditions existed in Central India, South Africa, and Australia. To explain these three glaciations, it has been suggested that the south pole was then somewhere in the Indian Ocean and that they were part of a circumpolar glacial belt. But if the pole had been equidistant from these three glaciated areas they would have been so far from it that they would have been in the temperate and tropical zones; whereas Ceylon, Southern India, and Eastern Equatorial Africa, though they would have been nearer the pole, have yielded no evidence that they shared this glaciation. Unluckily for the theory, there was a simultaneous glaciation in Brazil, which, with the assumed position of the poles, would have been equatorial; while the north pole would have been situated somewhere in the neighbourhood of Mexico, and that part of America, instead of having been covered by a polar ice-cap, was then enjoying a normal climate and had a rich vegetation. In later times the existence of tropical conditions in the arctic region has been assumed to explain the occurrence of plant beds in Greenland and Spitzbergen. Greenland is even said to have had a tropical climate about the date of the deposition of the English chalk. This claim is based on some fossil land-plants; but the available evidence as to the temperature of the adjacent seas at that period gives no indication that they were occupied by a tropical or even warm-water fauna.

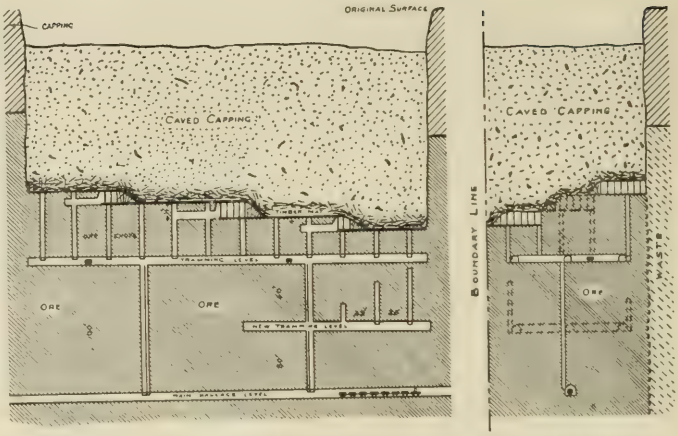
The evidence from the distribution of life shows that throughout geological time the climatic zones have run round the world in belts approximately parallel to those of the present period. There have been many great fluctuations in the boundaries of these zones, which projected in one place far to the north and in others were pushed southward. Such anomalies have perhaps never been greater than those which exist today, when on one coast of America, in Alaska, dense fir forests grow upon the beds of earth that actually rest upon the glaciers, while the same latitudes in eastern America are barren arctic wastes. The test of the former climatic zones was applied by Haughton, who discussed the question in a series of papers published between 1878 and 1882. He claimed that geological evidence is convincing that the north pole cannot have shifted its position, at least during the latter half of geological time. He especially considered whether the shifting of the pole would explain the formation of the arctic coals, and he claimed to have proved that during this coal period a belt containing a climate similar to that of Lombardy completely surrounded the north pole, which must then have been in its present position.

The evidence subsequently discovered has confirmed Haughton's conclusion and established it for other periods. For the explanation of the former existence of a climate with a temperature like that of Lombardy in arctic latitudes, many theories have been proposed. The explanation that has best stood the test of time is that of the meteorological effects of changes in the distribution of land and water. Lord Kelvin insisted that if the lands round the Arctic Ocean sank for 1000 ft. whereby the connections of the Atlantic and Pacific with the Arctic Ocean would be greatly enlarged, the temperature of the north polar region would be so much raised that the Arctic Ocean would be ice-free, and a low island at the north pole might be covered by vegetation and would not suffer even so much as hoar frost during its whole six months' night of win-

ter. That verdict by so great an authority on thermodynamics as Lord Kelvin allows us to attribute the great variations in antarctic climate to possible geographical changes; it renders unnecessary the appeal to extraneous influences, such as variation in the sun's heat or that shifting of the earth's axis which mathematicians dismiss as a fantastic impossibility and which geological evidence contradicts for the very times when the distribution of plants and glaciers would render the hypothesis most convenient.

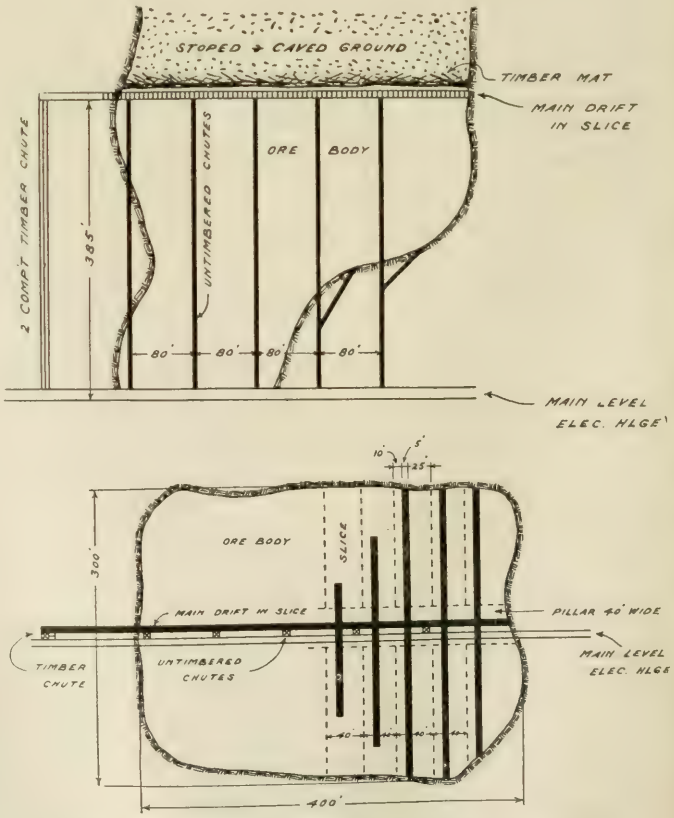
Slicing Methods in Arizona.—At the February meeting of the American Institute of Mining Engineers, P. B. Scotland presented a paper describing the mining methods adopted at the mines, in the Morenci-Metcalf copper district, belonging to the Arizona Copper Company, the headquarters of which are in Edinburgh. Owing to the great variety of the orebodies as regards width and hardness and character of the country rock, many different methods of mining have been adopted, open-cut, open stoping and filling, underhand stoping, shrinkage stoping, sub-level caving, rill-stoping, top-slicing, and panel-slicing. At one time, square-set timbering was also largely employed, but the method has been generally replaced by top-slicing.

We quote herewith instances of the applications of top-slicing and panel-slicing as adopted at this company's mines. Top-slicing is used in the mining of the large bodies of soft ore in the Humboldt mine. The top of the orebody is removed by square-setting or otherwise, and a double floor or mat of 2 in. plank laid, after which the overburden is caved on the mat, either to the ore or to a distance sufficiently high to make it safe to work beneath the mat. A tramming level is driven 55 ft. below the mat and side drifts divide the ore into blocks of 30 to 40 ft. in width. At intervals of 25ft. along these drifts, timbered rises, divided into chutes and ladderways, are carried upward to the mat. Commencing at the boundary of the ore, slices 11 ft. in height and 30 to 40 ft. in width are mined below the mat, which is temporarily supported by sets with posts 10 ft. high and round unframed caps. As the slice advances, a layer of 2 in. plank is laid on the floor, lengthwise with the slice, and the mat is caved by blasting the posts behind the working face. Only sufficient space is kept open under the mat to permit of shovelling into the chute. Connection is made between the chutes by means of short drifts ahead of the slice. These drifts may be small and untimbered, or carried the full height of the slice



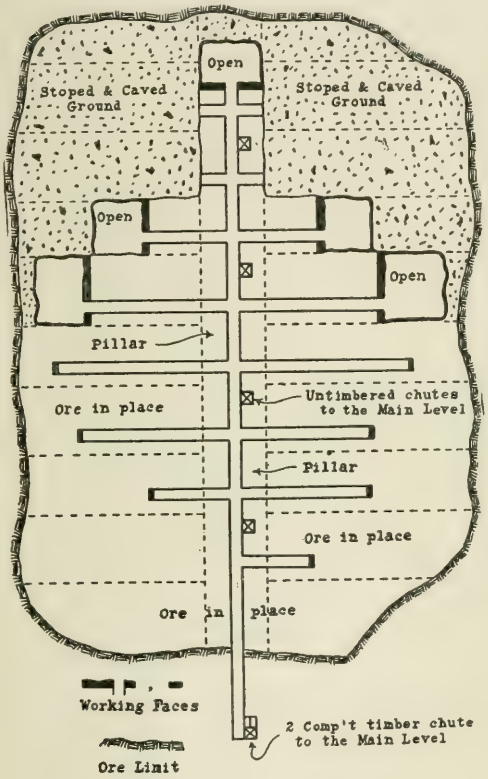
Longitudinal Section. End Section.

TOP-SLICING AT THE ARIZONA COPPER COMPANY'S MINES.



SECTION AND PLAN SHOWING PANEL-SLICING METHOD AT THE ARIZONA COPPER COMPANY'S MINES.

and timbered with 10 ft. sets to support the mat. The ore is delivered from the chutes into cars in the tramming level, and thence into cars in the main haulage level. In order to allow the broken ore to be always shovelled direct into the chutes, a modification in practice has been introduced. When the working face has advanced so far that the ore cannot be shovelled direct, the men are transferred to the next chute, and a new breast is opened and worked on all sides. In slices 30 ft. wide and with chutes 25 ft. apart, this system permits direct shovelling and avoids the use of wheelbarrows.



PLAN OF WORKING FACES, PANEL SLICING AT ARIZONA COPPER COMPANY'S MINES.

To eliminate the expense of installing and maintaining chute-rises 25 ft. apart, a system of panel-slicing is being adopted, whereby the ore is loaded direct into cars in the slice. All the working faces and all the tramming are on the same floor, and the use of tramming-levels at 55 ft. intervals is abandoned. The working level is divided into slices by cross-cuts every 40 ft. along the main road. The main road, and the parts of the cross-cuts forming the main-road pillar 40 ft. wide, are timbered with sets 6½ ft. high. Outside this area, the cross-cuts are opened through to the mat above, and timbered with slice-sets 10 ft. high. Slices 40 ft. wide are then worked from the margin of the ore toward the pillar over the roadway. This pillar is not removed until the slices on each side of it are exhausted. Ore-chutes spaced at 80 ft. intervals along the main level receive the ore trammed from the working faces. As one floor or panel is being worked, the next one 11 ft. below is in preparation.

Treatment of Silver Ores at Cobalt.—The April issue of the *Bulletin* of the Canadian Mining Institute contains a paper by E. B. Thornhill describing the method used at the Buffalo plant for recovering mercury used in the combined amalgamation-cyanidation process. We have on several occasions referred to the method devised by Charles Butters and G. H. Clevenger for treating high-grade silver ore mined at Cobalt by submitting it to amalgamation in a rotating barrel in presence of a strong solution of cyanide. It is found that a considerable amount of the mercury is retained in the residue, chiefly in the form of mercuric sulphide. At the Buffalo plant, any attempt to reduce this loss had an adverse effect on the extraction of the silver, so methods of recovery of the mercury from the residue were investigated. The method adopted was to leach with a solution of alkaline sulphide, preferably sodium sulphide, in the presence of caustic soda, and to precipitate the mercury from the double sulphide thus formed by means of granular aluminium. The equations representing these reactions are:

(1) $HgS + Na_2S = HgS.Na_2S$

(2) $3\ HgS.Na_2S + 2\ Al + 8\ NaOH = 3\ Hg + 6\ Na_2S + 2\ Na\ Al\ O_2 + 4\ H_2O$

It was found that practically the whole of the mercuric sulphide could be dissolved in 8 or 10 minutes, so it was decided to treat the filter-leaves direct in a separate vat instead of breaking the residue and treating it by agitation. The solution employed contains about 4% sodium sulphide and 1% sodium hydroxide, and about a ton of this solution is used per ton of residue. The mercuric solution is pumped to a precipitating vat, where it is agitated with granular aluminium. The mercury in the precipitate is found to exist to the extent of 25% as liquid, and 75% is in the form of powder mixed with other substances. The aluminium employed is a waste product of foundries and is about 75% pure. A quarter of a pound is consumed per pound of mercury recovered. The sodium aluminate in the solution does not accumulate, as some of the aluminium falls as hydrate of alumina with the mercury on precipitation, and some as calcium aluminate collects on the filter-cake. This removal of aluminium regenerates the caustic soda, so that the consumption of the latter is only one-tenth of a pound per pound of mercury, instead of half a pound as required by the equation. The sodium sulphide is also regenerated by the precipitation reaction, but as no advantage is gained by attempting to remove the solution from the filter-leaves by a subsequent wash, there is a mechanical loss of 20%. The price of sodium sulphide is $1·25 per cwt. on the cars at Toronto. The cost of the recovery process is 13 cents per pound of mercury, and from May 1914 to the date of the paper, 37,650 lb. of mercury had been recovered in this way.

The Origin of Kaolin.—In our last issue we gave an outline of the various theories of the origin of kaolin as enunciated by J. Allen Howe in his new book on 'Kaolin.' In the issue of *Economic Geology* for January, Waldemar Lindgren opens a discussion on this subject, inviting other geologists to give their opinions. The kaolin he has in mind is that occurring in mineral veins, not the massive form worked for china-clay. Mr. Lindgren holds that kaolin is not usually formed in deposits which are accredited to igneous emanations or to ascending thermal waters, the possible exception being when it is very close to the surface where admixture with meteoric waters has been effected. He argues that the fact that it contains two molecules of water, which can be driven off by

heat at temperatures from 450 to 500°C, shows that it is not a high-temperature mineral. Mr. Lindgren is of opinion that it is a product either of alteration by descending waters containing sulphuric acid or carbon dioxide, or of alteration effected close to the surface by ascending weak carbonated waters. His experience is that at or near the outcrops of orebodies, kaolin often occurs in large quantities, With depth it disappears, and at the water-level or a short distance below, the soft white mineral is generally found on examination to be sericite. This rule applies with certainty to all veins that have been formed in the neighbourhood of igneous masses shortly after the intrusion, and it probably applies also to veins formed near the surface. The inference is that the agency producing the mineral deposits, that is to say, heated waters under high pressure, are not capable of developing kaolin from the aluminium silicates of the rocks, but that sericite has first been formed, afterward the sericite in the oxidized zones having its potash removed by weak sulphuric acid waters with the production of kaolin. Another reason for considering that sericite was the first product of the reaction of hot ascending solutions on aluminium silicate rocks is adduced by experiments made by Lemberg. He found that hot solutions of potassium and sodium salts attack kaolin with the formation of alkaline silicates similar to sodalite, nepheline, or analcime, and the deduction is that kaolin will not be formed in the presence of hot ascending waters containing alkalies. Observations at hot springs, such as those at Carlsbad, tend to show that the granite through which the springs arise is changed to a zeolite having a resemblance to sericite. On the other hand examples can be given of felspars being changed to kaolin by the action of cold mineral waters highly charged with carbonic acid. No investigation has been made of a possible conversion of felspar to kaolin by hot waters containing no alkalies, and this eventuality does not appear to be worth considering, for it is practically certain that all such waters involved in the formation of orebodies were and are charged with alkalies.

Graphitic Schist and Cyanidation.—At the April meeting of the Institution of Mining and Metallurgy, W. R. Feldtmann read a paper describing experiments made by him with a view of improving the extraction of gold by cyanide when treating ore that contains graphitic schist. In West Africa, the quartz lodes worked by the Ashanti Goldfields company, for which Mr. Feldtmann is consulting engineer, pass through schistose country rock containing graphite, and it is in practice impossible to prevent some of this wall-rock going to the stamps and cyanide plant along with the ore. The low extraction of gold by the cyanide process has been shown to be due to the presence of the graphite in the schist. Roasting the ore or tailing before cyanidation would effectively remove the objectionable graphite, but the cost of this treatment would be out of all proportion to the improvement in the extraction to be expected. The Ashanti Goldfields is not the only mine worried by graphite in the wall-rocks, another notable case known to shareholders in mining companies recently being at Dharwar in India, where the efforts to solve the problem were abandoned. Mr. Feldtmann commenced his experiments by endeavouring to ascertain whether it was possible to add metallic salts, oxidizing agents, or other substances to the ore or tailing, in order to neutralize the graphite effect, before treating it with cyanide solutions, and he also tried adding various chemicals to the cyanide solutions. All these experiments gave negative results. A further set of investigations was therefore inaugurated, with a view of ascertaining a method of re-dissolving the gold precipitated on the graphite. Comparison was made with the precipitative action of charcoal on chloride solutions. The precipitate from the chloride solutions is in the form of metallic gold, and it can be re-dissolved by cyanide solution. On the other hand the precipitate from cyanide solution on the graphite of the schist is not re-soluble in fresh cyanide. The conclusion is that this precipitate is not in metallic form. Mr. Feldtmann is of opinion that it consists of a carbonyl compound of cyanide of gold, the combination with cyanogen and carbonic oxide being effected by the gases adsorbed on the surface of the graphite and unremovable by washing. After many chemicals had been fruitlessly tried for the purpose of re-dissolving this precipitate, it was found that an alkaline sulphide, particularly sodium sulphide, would act as a solvent, but a greater proportion of the gold than 75% could not be dissolved. This reaction suggests a method for treating the tailing after cyanidation and subsequent washing. The cost of the sodium sulphide and of the precipitation of the gold from the solution remains to be studied. Mr. Feldtmann states that the precipitation appears to be best effected by contact with metallic copper. As we mentioned in an editorial note last month, the use of an alkaline sulphide has not been suggested before for the commercial extraction of gold from ores, though the reaction has often been discussed by economic geologists in connection with the migration of gold in ore deposits.

Lonely Reef Orebody.—In the yearly report of the Lonely Reef company, the consulting engineer, C. B. Kingston, gives some details of the nature of the orebody. As has already been recorded in our pages, the mine is situated about 50 miles north of Bulawayo, Rhodesia, and contains an auriferous quartz lode, dipping nearly vertically, in a country consisting of schist, grits, and serpentine. Down to the 8th level, at 925 ft., the ore-shoot was persistent as regards length and gold content. At greater depth the length of the shoot diminished, and also the assay-value, though the width increased. The accompanying table gives details of the shoot, at the various levels. As the figures for the 12th and 13th levels refer to incomplete development, they cannot be taken to represent the actual conditions to be eventually disclosed. Mr. Kingston records that on the 4th level indications were observed of a fault in the plane of the lode, and a subsequent

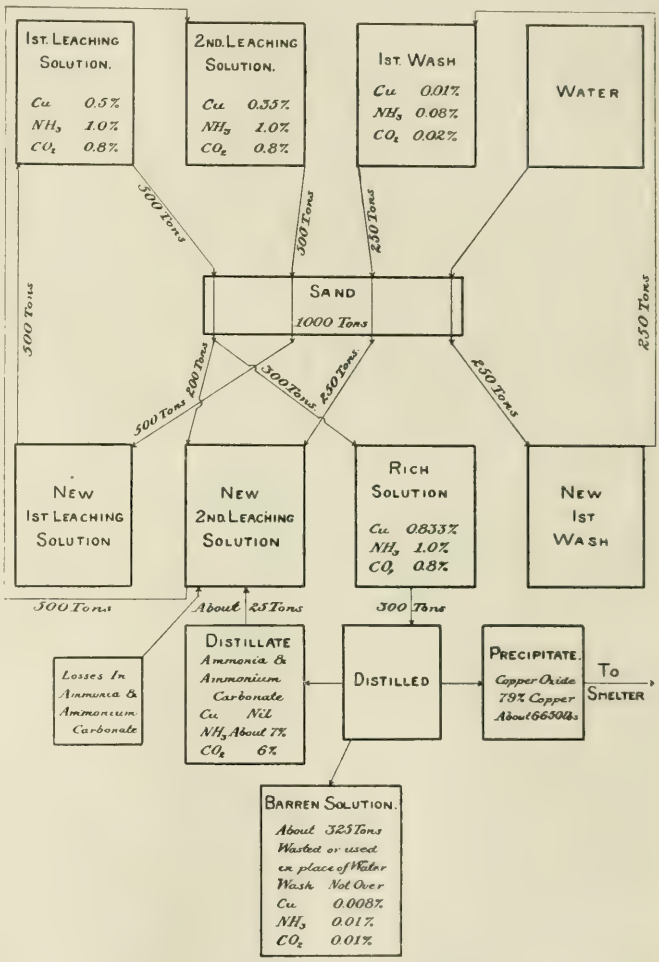
PARTICULARS OF LONELY REEF OREBODY.

Level	Depth ft.	Length, ft.	Average width, inches.	Assay value, dwt.
1	100	925	30·5	26·3
2	200	855	30·0	29·8
3	300	860	28·8	22·2
4	425	805	28·0	24·8
5	550	935	31·5	22·1
6	675	860	36·3	29·2
7	800	850	50·0	33·8
8	925	858	50·4	30·1
9	1,050	680	42·4	28·5
10	1,175	559	41·9	17·6
11	1,300	427	48·2	11·3
12	1,425	150*	49·7	14
13	1,550	—	30·0†	40†

* Length so far driven. † Figures for intersection of cross-cut with lode.

formation of a second body of auriferous quartz in the fissure-fault thus formed. These two distinct orebodies are separated by a clay selvage, and their distinct character is noted on every level from the 4th downward. The older orebody, which was worked from the surface downward, gradually diminishes in width, while the younger one increases in importance. On the 11th level the older orebody is very narrow, and is hardly distinguishable on the 12th level. The younger orebody increases in width with depth, and on the 12th level practically fills the fissure. The shortening of the ore-shoot from the 8th to the 11th level represents the contraction in length of the older orebody. On the 12th level the development is entirely in the newer orebody. The oxidation of the ore extends to the bottom of the older body, and on the 10th level the whole of the ore is oxidized. In the younger body little oxidation is to be found on the 10th and 11th levels, and on the 12th level no oxidation has so far been revealed. At the point of intersection of the cross-cut with the orebody on the 13th level, however, the ore is found to be oxidized on the footwall side, where water is making its way downward. The oxidation of ores at a vertical depth of 1550 ft. by means of meteoric waters is exceptional, and is worth noting.

Leaching with Ammonia.—We have on several occasions referred to the process devised by C. H. Benedict for leaching copper tailing at the Calumet & Hecla mine by means of solutions of ammonia. At this mine, in Lake Superior district, the copper occurs native. The *Mining & Scientific Press* for April 17 contains an article based on the United States patent specification 1,131,986, describing the nature of the process. Mr. Benedict begins by showing that the losses of ammonia, which have heretofore militated against the success of the application of ammonia to leaching, are due not so much to volatilization, as to adsorption. He finds that the adsorption by slime is much greater than by sand, and that the losses are, in a general way, proportional to the concentration of the ammoniacal solution. If the solution is dilute, containing say less than 2% of free ammonia, the adsorption losses when sand alone is treated and is substantially free from slime, are so small as not to interfere with the commercial value of the process. Another fact that has been against the use of the process, is that when dilute solutions are used, the plant has to be large, and the cost of erecting it has been prohibitive. The essence of Mr. Benedict's invention is that though dilute solutions are used a much smaller plant is required. The cycle of operations is such that a large part of the copper is concentrated in a small proportion of the total solution brought into contact with the ore, so that the plant used for distilling and precipitating the copper oxide and recovering the ammonia is much smaller, and the cost and losses thus reduced. The ore is subjected to two leaching operations and two washes, the contents of the four solutions employed being: (1) 0·5% Cu, 1% NH_3, 0·8% CO_2; (2) 0·35% Cu, 1% NH_3, 0·8% CO_2; (3) 0·01 % Cu, 0·08% NH_3, 0·02% CO_2; and (4) water only, or distillation reject containing only traces of copper and ammoniacal compounds. The first leaching solution contains ammonia, ammonium carbonate, and cupric-ammonium carbonate and consists of a previous second leaching solution. In conducting the process, 1000 tons of sand, which is finer than 40-mesh and free from slime, is run into a covered vat, say 54 ft. in diameter and 12 ft. high. The first solution amounting to 500 tons is fed from above, and the flow from the bottom regulated to obtain the desired period of contact of the solution and ore. The first portion of the effluent solution, say 200 tons, is poor in copper and low in ammonia, and is run into the sump for the second leaching solution. Afterwards the effluent, a further 300 tons, is richer in copper, and is sent to the distilling plant. On distilling, copper oxide is precipitated, and ammonia and ammonium carbonate are formed. The two latter are used in forming the second leaching solution, and the solution remaining after distillation containing traces of copper, am-



DIAGRAMMATIC FLOW-SHEET OF THE BENEDICT LEACHING PROCESS.

monia, and ammonium carbonate, may be employed as the second wash. After the right amount of first solution, 500 tons, has been delivered to the leaching vat, 500 tons of the second solution is run in at the top; and subsequently the first and second washes of 250 tons each follow. The second leaching solution after passing through the vat becomes the first leaching solution for the next batch of sand. The first wash after passing through the vat goes to the sump for the second leaching solution. The second wash becomes the first wash for the next batch of sand. The total amount of solution is about 1500 tons for each 1000 tons of tailing, and of this amount only 300 tons goes to the distilling plant. The relative amounts of each solution is so regulated that their composition shall practically remain constant. It will be seen that as only one-fifth of the total circulating solution goes to the distilling plant, the cost of erecting the whole installation is substantially lowered. The diagram given herewith explains the flow of the various solutions.

CURRENT LITERATURE

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.]

Stone-Dusting.—The *Colliery Guardian* for March 26 describes the plant for producing stone dust used for reducing the explosiveness of coal dust at Cadeby colliery, Yorkshire.

Lubricating Oil for Mining Plant.—The *Iron and Coal Trades Review* for March 26 publishes a paper by T. C. Thomsen on the use and abuse of oils in mining plant, read before the West of Scotland branch of the Association of Mining Electrical Engineers.

Stope-filling.—At the April meeting of the South Staffordshire and Warwickshire Institute of Mining Engineers, J. Drummond Paton read a paper on the application of hydraulic stowing in the Staffordshire coalfield.

Electric Power on the Rand.—At the April meeting of the Institution of Electrical Engineers, J. H. Rider presented a paper describing the electric-power supply of the mines belonging to the Central Mining-Rand Mines group.

Electric Signalling in Mines.—The *Colliery Guardian* for April 23 publishes Dr. R. V. Wheeler's report, made for the Government in connection with the Senghenydd explosion, on the dangers of electric signalling in coal mines.

Alaska Gastineau Mill.—The *Mining and Scientific Press* for April 17 contains an article by L. E. Spray describing the metallurgical plant of the Alaska Gastineau mine, near Juneau.

Cost of Mine Supplies.—The *Mining and Scientific Press* for April 3 publishes a paper by B. J. Silbert giving in great detail the consumption and cost of materials and supplies at the Tigre mine, Sonora, Mexico.

Crushing Efficiency.—In the *Mining and Scientific Press* for April 10, H. C. Kenney discusses Kick's law of the mechanical efficiency of crushing, but holds that the earlier formula enunciated by Rittinger better interprets the actual performance.

Leaching at Anaconda.—In the *Engineering and Mining Journal* for April 24, E. P. Mathewson describes the new leaching plant at Anaconda, to be used for treating accumulated tailing.

Roasting at Yuanmi.—The *Monthly Journal* of the Chamber of Mines of Western Australia for February contains an article by K. B. Moore and H. R. Edmands, describing the method of roasting the arsenical sulphide ore at the Yuanmi gold mine. The roasted ore is subsequently treated by the same process as the oxidized ore, as detailed in the issues of the same journal for October and November 1912.

Cyanide Practice at Nipissing.—In the *Engineering and Mining Journal* for March 27, E. M. Hamilton replies to criticisms of the process for precipitating silver from cyanide solution by means of aluminium. The criticisms were contained in papers by James Johnston and G. H. Clevenger, read at the February and August, 1914, meetings of the American Institute of Mining Engineers.

Great Slave Lake.—In the *Canadian Mining Journal* for March 15 and April 1, Gwynne G. Gibbins describes a trip in the Great Slave Lake district.

Canadian Mineral Production.—The *Canadian Mining Journal* for March 15 publishes John McLeish's report on the mineral production of Canada during 1914.

Bolivian Tin.—In the *Mining and Scientific Press* for March 27, Francis Church Lincoln describes the Milluni tin district, north of La Paz, Bolivia.

Ridder Mine.—The *Engineering and Mining Journal* for April 3 publishes an article on the Ridder mine, Siberia, based on information supplied by R. Gilman Brown and H. H. Knox.

Coal Mining in Mexico.—At the April meeting of the North of England Institute of Mining and Mechanical Engineers, E. O. Foster Brown read a paper describing coal-mining operations in Coahuila, Mexico.

Bauxite in Arkansas.—In *Economic Geology* for January, W. J. Mead describes the bauxite deposits in Arkansas, worked for the American Aluminium Company, giving particulars of the geology, origin of the deposits, and methods of working.

Infusorial Earth.—In the *Mining and Scientific Press* for April 10, S. H. Dolbear describes the uses of infusorial earth and enumerates its chief sources.

NEW BOOKS

Explosives: Their Manufacture, Properties, Tests, and History. Cloth, quarto, 640 pages, illustrated. By Arthur Marshall. London: J. & A. Churchill. Price 24s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This book makes its appearance at an opportune moment, when the manufacture of explosives and their use in warfare are so much discussed, not only by the expert but by the proverbial man-in-the-street. The civil and mining engineer also will welcome it, for it contains much information of what has been done during the last twenty years by the manufacturer in producing varying grades of explosives adapted to the different applications in connection with hard and soft ground and other conditions. Mr. Marshall holds the position of chemical inspector in the Indian Ordnance Department, and his point of view and his experience are governed by the military uses of explosives. He has supplemented his personal knowledge by extensive research and careful study. We have examined the book carefully, and we have come to the conclusion that, generally speaking, the author deserves commendation for his clear and reliable statements and descriptions. One notable feature is that the references to other publications are not too voluminous, and the reader is thus saved from much unnecessary investigation of unimportant details. Another is that patent literature is practically ignored; those who know that

patents, particularly in connection with explosives, are mainly theoretical and the precursors of actual investigations will thank Mr. Marshall for his appreciation of the unreliability of a patent specification as a basis of technical history. The book was obviously completed before the outbreak of war, so that many points of current interest receive no mention. For instance, the section devoted to the manufacture of nitric acid is meagre, and gives little indication of the existence of substitutes for Chile nitre as the raw material for its manufacture. As the supply of nitre to Germany has been stopped, alternative methods of obtaining nitric acid are of prime importance. The author dismisses the processes for making nitrogen from the atmosphere without mentioning them by name, merely stating that the acid produced by them is too dilute to be acceptable to the manufacturer of explosives. We are informed that this drawback has been removed recently. Other processes are in use in Germany at present, notably the synthetic method of making ammonia devised by Haber and Rossignol, and Hausser's process for producing the acid direct from coke-oven gases by exploding them with regulated amounts of oxygen, while the Serpek process for making ammonia from aluminium nitride is employed in France. We think also that sulphuric acid manufacture should receive greater attention, and details should be given of the contact processes, for these are used by all makers of explosives who produce their own acid. The author, no doubt, would also have told us, if the book had been written after the declaration of war, more of the possible sources of cotton suitable for gun-cotton and smokeless powders, and would have enlightened the average reader as to any advantage to be gained by preventing imports of raw cotton into Germany. The absence of this information on all these points is however no blemish to the book. The arrangement of the subject matter follows fairly closely the scheme adopted by Guttmann, and in fact it may be said that the book is more or less of the nature of a revision of Guttmann. Mr. Marshall has not so great a personal acquaintance with explosive manufacture as the older author, and in some places his descriptions of the processes are rather sketchy. Still, as we have already said, the book is a valuable one and it will be accepted as a standard.

We recommend the mining engineer to study the book with the object of improving his knowledge of explosives, for, be it admitted, he usually pays little attention to the subject. There is much opportunity for reducing costs by obtaining the right explosive for the particular class of rock and by economy in its use.

The Panama Canal. By R. E. Bakenhus, H. S. Knapp, and E. R. Johnson. Cloth, octavo, 260 pages, with maps, plans, and photographs. New York: John Wiley & Sons; London: Chapman & Hall. Price 10s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

Many books and articles have been written describing the Panama Canal; many, highly technical, from the point of view of the civil engineer, others, by publicists, discussing its probable influence on trade and political relations, but most of them frankly popular and characterized by an exaggerated theatricality of presentation. None of these are quite satisfying to the average reader in search of general and dependable information on the subject. His wants are likely to be filled by the present book, which, without being too technical, presents the subject in a concise and informative manner. Two of the authors are connected with the United States Navy, and the third has been commissioner on the canal traffic and tolls. The subject matter of the book has been published from time to time in the Proceedings of the United States Naval Institute, so that there is every reason for knowing that the facts and opinions are of first-hand importance and fully correct in all details. The language is clear and calm, and the gigantic nature of the enterprise has not played havoc with the authors' vocabulary. In the first part of the book, a historical account is given of previous attempts at penetrating the Panama isthmus by means of a waterway, with an account of the conditions to be considered by the United States Government when it decided to undertake the work. The construction of the canal is then described, special note being made of the Gatun dam and locks, the mechanical methods of operating the lock-gates, and of towing the ships, the excavation of the Culebra cut, etc. A succinct account is given of the geology of the country through which the Culebra cut was made, especially in relation to the slides caused by the undependable nature of the ground. In part 3 the economic conditions with regard to labour and sanitation and in relation to the cost of operations are discussed. Part 4 is devoted to a consideration of the political influence of the canal, and the effect of the canal in relationship to the United States Navy. Other sections deal with the international laws as affecting the canal, including accounts of the various treaties, with the commercial influence of the canal, and the revenue to be derived. Altogether the book is one to be highly commended.

The Chemistry of the Cyanogen Compounds. By Herbert E. Williams. Cloth, octavo, 440 pages. London: J. and A. Churchill. Price 10s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This book exhibits an enormous amount of research and collation on the part of the author, but unfortunately it is marred by so many misprints due to careless writing and bad proof-reading that it is impossible to wax enthusiastic over it. With a thorough revision of the names of chemists and chemicals, and an improvement in the style of expression, the book will take its place in the specialist's reference library. The work is divided into three sections, the first describing the host of cyanogen compounds and their general chemistry, the second dealing with the processes of their manufacture, while the third is concerned with their detection and estimation. As Mr. Williams was engaged for many years in South Africa as an analytical chemist, we may take it that the third section embodies a large proportion of his experience. As regards the second section, the processes described in detail are those connected with the by-products of gas manufacture, and we find little or no new information relating to the production of cyanide by the metallic sodium process or of cyanamide by the calcium carbide process.

The Mining Manual and Mining Year-Book for 1915. Edited by Walter R. Skinner. Cloth, octavo, 980 pages. London: Walter R. Skinner, and the *Financial Times*. Price 15s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

We pay our respects every year to Mr. Skinner for the great services rendered by him to the mining community, by issuing timely and accurate information relating to all the mining companies registered in England, and to some of the foreign companies whose shares are held here. Mr. Skinner will not disagree with us when we say the 'Mining Manual' and *The Mining Magazine* should be included in the equipment of everybody interested in mining.

COMPANY REPORTS

Cordoba Copper.—This company was formed by John Taylor & Sons in 1908 as a consolidation of the Cerro Muriano and North Cerro Muriano companies, operating copper mines in the south of Spain, 10 miles northeast of the city of Cordoba. Dividends were paid for the years 1912 and 1913. The report for the year 1914 shows that the grade of the ore has become lower, and during the seven months before the war the average monthly output of blister copper was only 228 tons, as compared with an average of 290 tons during 1913. On the outbreak of the war, the sale of the copper was interrupted, so that mining and smelting had to be suspended. Subsequently conditions changed, and smelting was gradually resumed, until an output of 150 tons per month was attained. The ore raised during the year was 87,870 tons, averaging 2·78% copper. The yield of blister copper was 1941 tons. During 1913, the output of blister copper was 3500 tons, and the ore mined was 119,069 tons. The ore reserve on December 31 was estimated at 155,270 tons averaging 2·87% copper, as compared with 206,489 tons averaging 3% at the end of 1913, and 200,025 tons averaging 3·35% at the end of 1912. As has previously been recorded, the Murex wet magnetic process was adopted at the mine a few years ago. During 1914, this plant treated 17,435 tons of middling and slime averaging 1·14% copper, for a yield of 1232 tons of concentrate averaging 9·5% copper. The assay of the tailing was 0·49% copper, and the recovery was 58·8 per cent. The accounts of the company for 1914 show an income of £120,540 and a loss £10,702.

Mason & Barry.—This company was formed in 1858 to acquire the San Domingos sulphur and copper mine at Mertola, Portugal, just over the Spanish border, on the same mineral belt as the Rio Tinto and Tharsis. In the year 1878, the company was expanded and public subscriptions invited. At the outbreak of war, the German market for pyrite used in sulphuric acid manufacture was lost, and the output was consequently restricted. The report for the year 1914 shows that 259,238 tons of ore was raised, as compared with 378,929 tons the year before. The dividend absorbed £27,775, being at the rate of 15%, as compared with 35% for 1913.

Tharsis Copper & Sulphur.—This company, with headquarters in Glasgow, operates the Tharsis and Calanas sulphur and copper mines in the south of Spain. As the pyrite is shipped chiefly to England and Scotland, no great inconvenience has been experienced from the war. But the low price of copper adversely affected the profits. The shipments of pyrite amounted to 501,037 tons, as compared with 508,287 tons in 1913, and in addition, 1611 tons of copper precipitate was shipped, as compared with 1534 tons in 1913. The total production of refined copper from pyrite and precipitate was 3605 tons, as compared with 3218 tons in 1913, though the increase was more than accounted for by purchases of precipitate. The dividend absorbed £156,250, being at the rate of 12½%, as compared with £250,000 and 20% the previous year.

Sons of Gwalia.—This company was formed in 1898 to acquire a gold mine at Mount Leonora, in the North Coolgardie district, West Australia. Bewick, Moreing & Co. are the general managers. Dividends have been paid since 1900, averaging about 20% per year. Three years ago the developments between the 13th and 17th levels were disappointing. Subsequently lateral diamond-drilling on the 18th and 19th levels, undertaken on the advice of Dr. Malcolm Maclaren, disclosed an important new lode parallel to the main lode, and the fortunes of the company were thereby revived. The report for the year 1914 shows that developments on the 20th level have continued to expose ore, and that the reserve has been maintained. Another level, the 21st, has been opened at a depth of 2992 ft. on the dip. During the year, 160,963 tons was raised, and the gold extracted by amalgamation and cyanide was 58,936 oz., worth £250,501, being a yield of 31s. 1d. per ton. The working cost was £175,564, London and other expenses £3700, taxes £5205, and allowance for depreciation £23,884. The shareholders received £48,750, the dividend being at the rate of 15%. The ore reserve on December 31 was estimated as being sufficient to supply the mill for three years and eight months.

Ivanhoe Gold Corporation.—This company was one of the late Whitaker Wright's promotions, but unlike many of his ventures has proved highly profitable. The property is adjacent to the Great Boulder Proprietary and Golden Horse-Shoe mines, in the richest part of the Kalgoorlie goldfield, West Australia. Since the Whitaker Wright collapse, Bewick, Moreing & Co. have been the consulting engineers, and R. B. Nicolson is manager. Three years ago, the development became disappointing, and Malcolm Maclaren was commissioned to make an examination and give suggestions as to future policy. Dr. Maclaren's advice was that the main shaft should be sunk deeper with the object of ascertaining whether ore would be found below the porphyry, which was encountered on the 2570-ft. level, and that boring should be done in certain directions. The report for the year 1914 shows that the main shaft has been sunk to 3215 ft., and bores started from the 2870 and 3170-ft. levels. So far, the extent of the porphyry has not been ascertained, and the continuation of the lode has not been found. The main shaft is to be sunk deeper and another borehole started at 3320 ft. During the year 1914, the ore raised was 218,420 tons, from which gold worth £364,804 was extracted, being a yield of 33s. 3d. per ton. The dividends absorbed £105,000, being at the rate of 10s. 6d. per £5 share. The yield was less by £90,000 as compared with 1913, and the amount distributed as dividend £45,000 less. The ore reserve on December 31 was estimated at 998,718 tons averaging 37s. 3d. per ton, figures not much different from those of the year previous, so that development in the levels above the zone of impoverishment has added substantially to the available ore reserve.

Mount Boppy Gold.—This company was formed in 1899 by John Taylor & Sons to acquire a gold mine in the Cobar district of New South Wales. At the same time the metallurgical plant of the Gallymont mine was purchased. Dividends were paid regularly from 1902 to 1911. In the middle of 1912 operations were considerably curtailed owing to drought, and it became necessary to issue 30,000 preference shares of £1 each carrying 10% dividend to pay for new plant then being erected for the treatment of sulphide ore instead of paying for it out of revenue. For the year 1913, the preference shares received their dividend. The report for the year 1914 shows that 70,059 tons of ore was raised and treated for a yield of 30,788 oz. worth £130,788. The working profit was £35,416, out of which £3000 has been paid as dividend on the preference shares, and £11,325 as 7½% dividend on the preference and ordinary shares, while £5000 is allowed for depreciation and £15,000 placed to reserve. The development during the year has disclosed no ore below the 700-ft. level, but extensions

of the orebody between the 300-ft. and 600-ft. levels have been proved, and the reserve has been maintained thereby. The reserve was estimated on December 31 at 199,559 tons.

Broken Hill Proprietary.—The report of this company for the half-year ended November 30 shows that on the outbreak of war the tonnage raised from the mine was reduced, but the lead smelters were kept at work uninterruptedly, larger proportions of material coming from the adjoining mines. The output of zinc concentrate was greatly reduced. The zinc-smelter was working full time, and the surplus zinc concentrate was stored. Contracts have since been made with American buyers for the sale of 45,000 tons of zinc concentrate, with the probability of the amount being extended. Difficulties were at first experienced in disposing of the refined lead and lead bullion, the position, however, becoming normal again later. The amount of sulphide and carbonate ore raised from the mine was 121,316 tons, as compared with 147,577 tons the previous half-year. At the concentration plant, 111,489 tons of sulphide ore was treated for a yield of 20,060 tons of lead concentrate, and 78,124 tons of tailing yielded 15,851 tons of zinc concentrate. The lead-smelters treated 64,413 tons of lead concentrate, 9681 tons of oxidized ore, and 2659 tons of residue from the zinc retorts. The zinc-smelter treated 7773 tons of zinc concentrate, for a yield of 2341 tons of zinc and 342 tons of blue powder. The progress of the iron industry has already been recorded in our columns. The accounts show a profit of £125,611, of which £59,050 has been distributed as dividend, at the rate of 1s. per 8s. share.

PART OF SOUTH AUSTRALIA, INCLUDING BROKEN HILL, PORT PIRIE, AND IRON KNOB.

Broken Hill South Silver.—The report of this company for the half-year ended December 31 shows that on the outbreak of war the contract for the sale of the lead concentrate to Germany was terminated, and an arrangement was made with the Broken Hill Proprietary whereby concentrate amounting to about half the usual output was delivered to the Port Pirie smelter for treatment. The mine has been worked on alternate weeks. The current zinc tailing has been despatched uninterruptedly to the plant of the Amalgamated Zinc (De Bavay's). The amount of ore raised was 111,891 tons averaging 15·3% lead, 14·2% zinc, and 7·1 oz. silver per ton, as compared with 172,421 tons during the previous half-year. At the concentrator 20,375 tons of lead concentrate was produced averaging 64·9% lead, 8·3% zinc, and 21·6 oz. silver, together with 69,943 tons of zinc tailing averaging 16·9% zinc, 3·1% lead, and 3·3 oz. silver per ton. The Zinc Corporation took delivery of 8312 tons of old zinc tailing, of which there is still 891,835 tons awaiting treatment. Among other products on hand is 394,733 tons of slime averaging 11·1% lead, 14·1% zinc, and 6 oz. silver. The ore reserve in the mine remains at 3,350,000 tons. During the half-year the development has maintained the reserve, and notably has disclosed ore of average grade in the northern orebody, on the 1270-ft. level. The accounts show a working profit of £53,969, but against this is an item of £128,000 for metals unrealized and concentrate on hand. The company has been able to pay its way by withdrawing £75,000 from the reserve fund.

North Broken Hill.—The report of this company for the half-year ended December 31 shows that, owing to the war, the mine and mill were in operation for 16 out of the 26 weeks. The amount of ore raised was 102,735 tons averaging 16% lead, 13·6% zinc, and 7·4 oz. silver per ton. The yield of lead concentrate was 19,063 tons averaging 66·1% lead, 6·8% zinc, and 21·5 oz. silver. Of this amount, 3767 tons was delivered to German buyers, and the remainder sent to the Proprietary's smelter for treatment under the arrangement described elsewhere. The German contract called for a 70% content of lead, but with local smelting the concentration is not required to be so close, the Proprietary finding 60% desirable. Zinc tailing to the amount of 50,931 tons averaging 17·6% zinc, 3·5% lead, and 3·7 oz. silver was delivered to the Amalgamated Zinc (De Bavay's). The accounts show a profit of £116,121, of which £10,000 has been written-off for depreciation, and £10,000 placed to reserve, the balance being carried forward. The reserve of ore above the 1400-ft. level is estimated at 3,000,000 tons. We have already recorded the excellent results of development on this level.

Globe & Phœnix.—This company was formed in 1895 to acquire gold mines in the Sebakwe district of Rhodesia, 140 miles north of Bulawayo. The Globe did not last long, but the Phœnix has been a most profitable mine. Below the dike between the 15th and 16th levels, the results of development have not been so uniformly satisfactory, but so far the profits and reserves have been maintained. The report for the year 1914 shows that in the 14th and 15th levels ore of high grade is still being developed. On the 20th level, the northern drift has disclosed ore for 1047 ft. averaging 24·4 dwt. per ton over a width of 32 in., though this ore is not consecutive, but in a

series of shoots. The results on the 21st level are not given in detail, and references are only made to two points where favourable results have been obtained. The reserve at December 31 was estimated at 194,400 tons averaging 29·5 dwt. per ton as compared with 180,757 tons averaging 27·2 dwt. the year before. No details are given of the ore raised during the year, but in the accounts the revenue from the sale of bullion is given at £485,007, and the shareholders receive £240,000, the dividend being at the rate of 120%. Operations were impeded by drought, and in October and November the mill and the cyanide plant worked short time. In December the rainy season commenced, and the supply of water was then greater than desired, so that another interruption of work was caused.

Lonely Reef.—This company was formed in 1910 by Lewis & Marks to acquire a group of partly developed gold mines together with a metallurgical plant, situated 55 miles north of Bulawayo, Rhodesia. Down to the 8th level the developments were highly satisfactory, but below that level the ore-shoot is shorter and not so rich. As the shoot pitches farther to the south at the lower levels, the shaft is inclined from the 9th level downward. The report for the year 1914 shows that on the 11th level the shoot is 427 ft. long averaging 11·3 dwt. over 48 in., as compared with 858 ft., and 30 dwt. over 50 in. on the 8th level. On the 12th level the work so far done amounts to 150 ft., and at the end of both north and south drifts the faces are still in ore. The average assay-value of the 150 ft. is 14 dwt. over 49 in. On the 13th level the lode has been intersected by a cross-cut, where it averages 40 dwt. over 30 in. During the year, 61,590 tons of ore averaging 16·6 dwt. per ton was milled, for a yield of 44,943 oz. of gold, worth £190,022, being an extraction of 14·6 dwt. per ton. The working profit was £93,934, out of which £5846 was paid as taxes, £40,083 written-off for capital expenditure and depreciation, and £50,023 distributed as dividend, being at the rate of 20%. The ore reserve on December 31 was estimated at 140,042 tons averaging 14·6 dwt. gold per ton, a fall of 32,515 tons and 2½ dwt. during the year.

Robinson Gold.—As we have recorded on several occasions during the last three years, this celebrated mine, in fact it may be called the premier mine of the Transvaal, is rapidly approaching exhaustion. Attempts were made a year or two ago to effect an amalgamation with the Crown Mines, but holders of Robinson shares objected to the application of the reserve funds in this way. The report for 1914 shows that 620,429 tons of ore was raised, and together with 61,003 tons taken from the dumps, was sent to the sorting station. After the removal of 6% waste, 638,000 tons averaging 33s. 6d. per ton was sent to the stamps. The yield by amalgamation was 169,768 oz. and by cyanide 74,428 oz., a total of 244,196 oz. worth £1,025,416, or 32s. 2d. per ton milled. The working cost was £455,063 or 14s. 3d. per ton, leaving a working profit of £570,352 or 17s. 11d. per ton. Out of the profit, £46,338 was paid to the Government in respect of undermining rights, and £50,583 as profits tax. The dividends absorbed £495,000, being at the rate of 18%, and £275,000 was distributed as a bonus at the rate of 10% out of accumulated profit. The ore reserve in the Main Reef Leader and South Reef on December 31 was estimated at 364,700 tons averaging 45s. per ton, and in addition 330,100 tons is expected to be recoverable from old workings, pillars, and packs. In the Main Reef, 534,300 tons is estimated to average 4·4 dwt. per ton. As development has reached the boundaries, no further ore can be expected, and the end of the mine is not far off.

Crown Mines.—This company was formed in 1909 as an amalgamation of the Crown Reef, Crown Deep, Robinson Deep, Langlaagte Deep, and other properties in the central Rand. The consolidation involved a reorganization and unification of the underground work at these mines. It was subsequently found necessary to issue £1,000,000 debentures in order to provide further funds for the reorganization. The dividend prognosticated at the time of the amalgamation was 130%. This has not been realized, for the figures have not been higher than 110%, while for the second half of 1914 the distribution was at the rate of 60% per annum. The report for the year 1914 shows that 2,558,668 tons of ore was raised, and after the rejection of 10% waste, 2,287,600 tons averaging 27s. per ton was sent to the stamps. The yield of gold was 509,644 oz. by amalgamation and 198,313 oz. by cyanide, a total of 707,257 oz., worth £2,975,687, or 26s. per ton milled. The working cost was £1,784,059 or 15s. 7d. per ton, leaving a working profit of £1,191,628 or 10s. 5d. per ton. Out of the profit, £90,058 was devoted to capital expenditure, £48,325 was paid as debenture interest, £131,591 was paid as profits tax and rent for undermining rights, £85,050 was applied to the redemption of debentures, £69,464 was written off development account, and £799,090 was distributed as dividend, being at the rate of 85%. The development work done during the year exposed 1,742,700 tons of an unspecified assay-value. The reserve of available ore was 9,369,000 tons averaging 5·9 dwt., a fall of 427,000 tons and 0·8 dwt. in assay-value as compared with the figures a year ago. The development in the South Reef on the 14th and 15th levels in the eastern section has been disappointing. The report does not say anything about the fall in the yield per ton during the last few months. H. Stuart Martin has resigned as consulting engineer, and R. C. Warriner now holds this position as well as being general manager.

City Deep.—This company belongs to the Rand Mines group, and was formed in 1899 to acquire property in the central Rand on the dip of the City & Suburban and Meyer & Charlton. In 1908, adjoining property on the dip of the Wolhuter and New Goch was acquired. It was not until 1908 that development was seriously taken in hand. As we have recorded in previous issues, the metallurgical equipment was far in advance of development, and much disappointment has been occasioned thereby to investors. The report for the year 1914 shows that the profits are gradually increasing, though the capacity of the treatment plant has not been reached. The amount of ore raised was 547,926 tons, and after the rejection of 7% waste, 505,800 tons averaging 39s. per ton was sent to the mill. The yield of gold by amalgamation was 140,044 oz., and by cyanide 90,222 oz., a total of 230,266 oz., worth £965,710, being 38s. 2d. per ton milled. The working cost was £566,933, or 22s. 5d. per ton, leaving a working profit of £398,777, or 15s. 9d. per ton. Out of the profit, £69,562 was spent on capital account, chiefly on shaft-sinking, and £39,744 was paid as profits tax. The shareholders received £296,875, the dividend being at the rate of 23¾%. The reserve at December 31 was estimated at 2,510,800 tons, averaging 9·7 dwt. per ton, of which 2,329,000 tons averaging 10·2 dwt. was in the Main Reef Leader. In some parts the Main Reef is so close to the Leader that simultaneous stoping may be effected, but as the average content of the Main Reef is only 3·7 dwt. or 15s. 6d. per ton, which is much below the average cost, the amount to be included will naturally depend on circumstances. The

South Reef is entirely unprofitable. During the year, the circular vertical shaft, sunk for the purposes of ventilation near the Wolhuter border, has been completed. The sinking of No. 1 shaft has also been finished; this is in the eastern section below the New Goch. The continuation of the sinking of the incline shaft following the No. 2 vertical shaft in the western section has been delayed by the fact that part of the electric hoisting plant was ordered from Germany. Duplicates have since been ordered from England. As mentioned above, the amount of ore treated is still far from the expectations when the metallurgical plant was built; during 1914 only 140 out of 200 California stamps and 4 out of the 8 Nissen stamps were at work.

Village Deep.—This company belongs to the Rand Mines group, and was formed in 1898 to acquire property in the central Rand on the dip below the Village Main Reef, which in turn is below the outcrop mines, Wemmer, Salisbury, Jubilee, and the west part of City and Suburban. In 1908, a large extension southward was purchased from the Turf Mines company. Milling started in 1905 and dividends were first paid in 1908. The ore in the upper parts of the mine was raised through two shafts near the northern boundary, but more recently the ore from the lower parts now being exploited is hoisted through the Turf or No. 3 shaft, the upper part of which is vertical subsequently following the dip of the deposit. The report for 1914 shows that the development has been of a satisfactory nature, as the whole of the work has been in profitable ore. The reserve has been more than maintained, though 6068 ft. less of development was done. The amount of ore disclosed was 624,564 tons averaging 8 dwt. per ton, the tenor being 1·4 dwt. higher than that of the ore developed during the previous year. The reserve at December 31 was estimated at 2,853,470 tons averaging 6·8 dwt. per ton. The consulting engineer, H. Stuart Martin, states that the outlook is better than ever before. During the year, 674,101 tons of ore was raised, and after the rejection of 11% waste, 600,250 tons averaging 29s. 1d. per ton was sent to the mill. The yield by amalgamation was 139,034 oz. and by cyanide 60,724 oz., a total of 199,758 oz., worth £838,774, or 27s. 11d. per ton milled. The working cost was £530,370 or 17s. 8d. per ton, leaving a working profit of £308,404 or 10s. 3d. per ton. Out of the profit £19,342 was spent on capital account and £25,967 was paid as profits tax. The dividends absorbed £225,392, being at the rate of 21¼ per cent.

Meyer & Charlton.—This company belongs to the Albu group and was formed in 1888 to acquire a property on the outcrop in the central Rand. In 1909 an additional block of 83 acres on the dip was acquired. The results of development in the lower levels have been highly gratifying during the last three years, and the report for 1914 shows that the position has become still more favourable. On December 31 the reserve was estimated at 469,839 tons averaging 13·88 dwt. per ton over 54 in., as compared with 471,844 tons averaging 11·7 dwt. the year before. Of the reserve, 272,395 tons is in the Main Reef Leader and averages 20·32 dwt. over 46 in. During the year, 185,326 tons was raised, and after the rejection of 8150 tons waste, 177,176 tons was sent to the mill. The yield by amalgamation was 43,155 oz., by cyanide 53,090 oz., and from concentrate 2369 oz., a total of 98,614 oz., worth £416,558, being 11·13 dwt. or 47s. per ton milled. The working cost was £155,393 or 17s. 6d. per ton, leaving a working profit of £261,165 or 29s. 6d. per ton. Out of the profit, £25,666 was paid as profits tax, and £27,891 in respect of undermining rights. The shareholders received £140,000, the dividend being at the rate of 70%, and the cash resources were increased by £72,000. From the commencement of mining in 1888 to the end of 1914, the ore milled has totalled 2,482,980 tons, for a yield of gold worth £4,906,083, and £1,435,308 has been distributed as dividends.

Consolidated Langlaagte.—This company belongs to the Barnato group, and was formed in 1902 to acquire the Crœsus and Langlaagte properties in the west part of the central Rand. The first dividend was paid in 1913. Much money was spent two years ago on a new mill and on developing the ore on the south of the Ferreira-Crown Reef dike. The Main Reef Series is 1100 ft. nearer the surface on the south of the dike than on the north, so that a new scheme of development was necessary and two shafts were sunk. The report for the year 1914 shows that these shafts have been connected on the 8th level, a 10th level opened at the East shaft, and a 9th at the West shaft. The assay-value of the ore exposed during the year was highly encouraging, and the reserve at December 31 was estimated at 2,220,707 tons averaging 6·9 dwt. per ton. The amount of ore sent to the sorting station was 594,952 tons, and after the removal of 2·8% waste, 578,100 tons averaging 6·37 dwt. was sent to the mill, which contains 100 stamps and 10 tube-mills. The yield by amalgamation was 122,436 oz., and by cyanide 51,114 oz., a total of 173,650 oz. worth £737,548, or 25s. 6d. per ton. The working cost was £427,165, or 14s. 9d. per ton, leaving a working profit of £310,383, or 10s. 9d. per ton. Allowance of £46,748 was made for depreciation, £27,391 was paid as profits tax, £14,850 was paid as debenture interest, and the shareholders received £190,000, being at the rate of 20%. Also £30,000 has been devoted to the purchase of debentures, of which £270,000 are now outstanding.

Modderfontein B. Gold Mines.—This company was formed in 1908 by the Rand Mines group to develop property in the far east Rand to the east of the New Modderfontein. The banket is covered by rocks of the Karoo age. The dip is not more than 14°, and the development has been done on coal-mining methods, using separate mechanical haulage-ways. In the western section, large amounts of high-grade ore have been exposed, but in the eastern section the ground is much broken and development is difficult. The report for the year 1914 shows that the milling capacity was increased in August, when 16 Nissen stamps came into operation, and the extension of the plant will be completed when another tube-mill now in course of erection starts work. The amount of ore sent to the sorting station was 489,125 tons, and after the rejection of 10% waste, 440,100 tons was sent to the stamps. The yield of gold by amalgamation was 101,010 oz., and by cyanide 86,865 oz., a total of 187,875 oz. worth £788,867, or 35s. 10d. per ton milled. The working cost was £342,526, or 15s. 7d. per ton, leaving a profit of £446,340, or 20s. 3d. per ton. As compared with the previous year, the tonnage milled showed an increase of 35,420, the yield per ton a fall of 2s. 11d., the cost per ton a decrease of 9d., and the working profit a fall of £7189. Out of the working profit, £41,592 was allocated to capital expenditure, and £44,335 was paid as profits tax. The shareholders received £385,000, the dividend being at the rate of 55%. The development during the year disclosed 930,700 tons averaging 8·7 dwt. per ton, and on December 31 the reserve was estimated at 2,772,540 tons averaging 8·6 dwt. In the eastern section, where the ground is much broken, a drift from No. 9 shaft in an easterly direction has disclosed ore of average grade for a distance of 640 ft. The westerly drift is not on the lode, owing to faulting,

but it is to be continued to connect with the other workings in order to assist ventilation.

Van Ryn Deep.—This company belongs to the Barnato group, and owns a deep-level property in the far east Rand on the dip below the Kleinfontein and Benoni. Milling commenced in July 1913. The report for the year 1914 shows that development has given highly satisfactory results, especially in the eastern section below Kleinfontein, where large blocks of ore have been added to the reserve. The reserve was estimated on December 31 at 1,692,349 milling tons, calculated to yield 36s. per ton. During the year, 547,038 tons was sent to the sorting station, where 12% waste was removed. At the mill, 483,090 tons averaging 8·15 dwt. per ton was treated, for a yield of gold by amalgamation of 125,175 oz. and 64,561 oz. by cyanide, a total of 189,736 oz., worth £806,372 or 33s. 5d. per ton. The working cost was £399,613 or 16s. 6d. per ton, leaving a working profit of £406,759, or 16s. 11d. per ton. Out of the profit, £38,268 was paid as profits tax, and £299,223 as dividend, being at the rate of 25%.

New Kleinfontein.—This company belongs to the Anglo-French Exploration group, and was formed in 1893 to acquire an outcrop property in the far east Rand. In March 1914, the adjoining Benoni and Apex gold properties were absorbed, on terms recorded at the time. In July, resolutions were carried to raise £115,000 additional working capital, to be applied to the development of the mines of the absorbed companies and to the reorganization of their plants. The issue of these shares was vetoed by the Treasury, so the money is to be provided out of profits. The report for the year 1914 shows that the ore reserve at Kleinfontein is 1,781,231 tons averaging 5·47 dwt. per ton, as compared with 1,658,481 tons averaging 6·3 dwt. the year before. The reserve in the Benoni is estimated at 621,853 tons averaging 5·6 dwt., and in the Apex 487,647 tons averaging 6 dwt. A general rearrangement of the methods of working the consolidated properties has been prepared. There are eight shafts over the 4¾ miles on the strike, five of them on the Kleinfontein, two on the Benoni, and one at the Apex. During the year 1914, the ore raised at the Kleinfontein was 742,736 tons, and after the rejection of 19% waste, 601,000 tons averaging 6·6 dwt. was sent to the mill. The yield of gold by amalgamation was 126,148 oz. and by cyanide 62,535 oz., a total of 188,683 oz. worth £801,789 or 26s. 8d. per ton. The working cost was £528,847, or 17s. 7d. per ton. The shareholders received £115,154, the dividend being at the rate of 10%.

Geduld Proprietary Mines.—This company belongs to the Goerz group and was formed in 1899 to acquire gold-mining property in the far east Rand, to the southeast of the Modderfontein. Development was not commenced until 1904. Three shafts were begun, and two of them were continued, Nos. 2 and 3, cutting the banket at depths of 1694 ft. and 1839 ft. respectively. Milling began in 1908, but was suspended shortly after the start owing to an unexpected inrush of water, not to be resumed until February 1910. In July 1913, the plant was increased, and now contains 60 stamps and 5 tube-mills. The report for 1914 shows that labour scarcity has interfered with the scheme for expanding the scale of development and milling. Conditions have recently improved, and probably a commencement will be made with the scheme within the current year. During 1914, 273,248 tons of ore was mined, and after the rejection of 10% waste, 244,385 tons averaging 8 dwt. per ton was sent to the mill. The yield of gold by amalgamation was 49,297 oz. and by cyanide 44,068 oz., a total of 93,365 oz. worth £395,457, being an extraction of 7·6 dwt. or 32s. 4d. per ton. The working cost, including development redemption, was £298,489, or 24s. 5d. per ton, leaving a working profit of £96,968 or 7s. 11d per ton. Out of the profit, a dividend of £46,125 was paid, being at the rate of 5%, this being the first return to shareholders. The ore reserve on December 31 was estimated at 1,900,000 tons averaging 7·1 dwt. over 59 inches.

Langlaagte Estate and Gold Mining.—This company was formed by J. B. Robinson in 1889 to work an outcrop property in the central Rand, and for some years the mine was one of the leading producers. In 1909 adjoining properties belonging to the Block B and Langlaagte Exploration companies were absorbed, as the mine was nearing exhaustion. The report for the year 1914 shows that 589,619 tons of ore was treated, for a yield of 82,786 oz. by amalgamation and 68,388 oz. by cyanide, besides which 18,114 oz. was extracted from 117,802 tons of accumulated slime. The total revenue was £716,697, and the working profit £185,854. Out of this profit, £22,358 was allocated to capital expenditure, £11,590 paid as profits tax, £4693 as rent of dumping ground, £13,495 as contribution to the Miners' Phthisis fund, and £88,650 was distributed as dividend, being at the rate of 10%. The ore in the old mine is now practically exhausted, and within a few months the output will come entirely from Block B. Since the purchase of Block B, the development has given uneven results, but during the last year or so conditions became more encouraging. On December 31 the reserve was estimated at 886,396 tons averaging 6 dwt. per ton, showing an increase of 227,582 tons during the year.

Randfontein Central.—This company was formed in 1911 as an amalgamation of the Central and South companies working gold mines in the far west Rand under the control of J. B. Robinson. The report for the year 1914 shows that 2,642,357 tons of ore was raised, and after the rejection of 5·6% waste, 2,493,924 tons averaging 5·8 dwt. per ton was sent to the mills, The average number of stamps employed was 883 out of 1000. The yield of gold was 686,330 oz. worth £2,885,599, or 23s. 1d. per ton milled. The working cost was £2,071,825 or 16s. 7d. per ton, leaving a working profit of £813,774 or 6s. 6d. per ton. As compared wiih the previous year, the ore milled was 39,059 tons less, the yield per ton 1s. 4d. less, the cost per ton 7d. less, and the working profit £107,360 less. Out of the profit, £81,600 was devoted to the redemption of debentures, £176,736 was paid as debenture interest, £52,877 as profits tax, £62,404 as contribution to the Miners' Phthisis fund, and £303,757 allocated to capital expenditure. After other small items had been charged, the balance remaining was £101,361, which was carried forward. A year ago the shareholders received £419,370, being at the rate of 10%. On December 31, the ore reserve was calculated at 6,826,644 tons averaging 6·6 dwt., figures practically the same as the year before.

It is interesting to record here the results obtained during 1914 at the three big consolidations on the Rand. Crown Mines treated 2,287,600 tons for a yield of £2,975,687, and distributed £799,090 as dividend; East Rand Proprietary treated 1,831,950 tons for a yield of £2,509,116, and paid £428,032 as dividend; and the Randfontein Central treated 2,493,924 tons for a yield of £2,885,599, and paid no dividend. All three companies have debenture debts, the Crown Mines £914,950, the East Rand Proprietary £1,260,000, and the Randfontein Central £2,918,400.

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Scientia non habet inimicum nisi ignorantem.

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STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
July, 1914	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3,202,514
April	717,225	26,855	744,080	3,160,651
May	737,752	25,796	763,548	3,160,651

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1914	154,202	9,471	11,979	175,652
February 28	157,673	9,508	12,266	179,447
March 31	162,815	9,619	13,390	185,824
April 30	165,005	9,625	14,150	188,780
May 31	165,433	9,619	14,284	189,336
June 30	166,248	9,442	13,256	188,946
July 31	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
January 1914	1,902,733	27 4	18 2	9 3	876,577
February	1,861,442	26 10	17 11	8 10	823,654
March	2,094,098	26 4	17 3	9 1	945,000
April	2,075,561	26 6	17 3	9 3	955,600
May	2,196,287	26 3	17 0	9 3	1,011,968
June	2,178,161	25 5	17 1	9 5	1,025,629
July	2,281,717	25 10	16 9	9 1	1,032,562
August	2,261,800	25 5	16 8	8 9	988,567
September	2,188,939	25 11	16 9	9 1	989,859
October	2,301,795	25 8	16 8	8 9	1,004,264
November	2,192,365	26 3	17 0	9 0	982,346
December	2,167,056	25 11	17 3	8 6	917,662
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

Production of Gold in West Africa.

Year 1912	Year 1913	Year 1914	April 1915	Year 1915
£1,497,179	£1,634,700	£1,727,044	£149,978	£591,431

Production of Gold in Rhodesia.

Year 1912	Year 1913	Year 1914	April 1915	Year 1915
£2,707,368	£2,903,267	£3,530,207	£315,541	£1,195,149

Gold Output of India.

Year 1912	Year 1913	Year 1914	May 1915	Year 1915
£2,265,094	£2,299,315	£2,340,259	£199,786	£988,108

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
July, 1914	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435,164
September	1,535	103,577	105,112	446,485
October	2,028	99,366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900
March	1,829	91,872	93,764	398,282
April	1,017	101,592	102,609	435,853
May	2,311	101,359	103,670	440,360

Other Australian Gold Production.

	1913	1914	Apr. 1915	1915
	£	£	£	£
Victoria	1,847,400	1,740,300	109,300	444,300
Queensland	1,118,610	1,011,310	97,320	325,490

Exports of Copper from United States
(Reported by United States Customs).

Month	Long Tons	Month	Long Tons
July, 1914	34,145	January, 1915	28,197
August	19,676	February	12,066
September	23,866	March	29,725
October	28,995	April	20,481
November	20,170		
December	16,830		

Nigerian Tin Production.
In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Year 1914 tons	April 1915 tons	Year 1915 tons
2,532	5,032	4,832	444	1,637

Production of Tin in Federated Malay States.
Estimated at 70% of concentrate shipped to smelters.

1911 tons	1912 tons	1913 tons	1914 tons	April 1915 tons	1915 tons
43,967	48,250	50,128	49,042	3,619	15,447

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January 4, 1915	328¾	£28,353	£86 4 11
January 18	214½	£18,785	£87 13 8
February 1	215¾	£19,892	£96 13 8
February 15	227½	£21,801	£95 16 7
March 1	218¼	£21,208	£97 3 5
March 15	205½	£20,625	£100 7 3
March 29	224¾	£21,360	£95 0 10
April 12	201	£19,328	£96 3 2
April 26	209	£18,928	£90 11 4
May 10	198½	£18,302	£92 4 1
May 25	180¾	£16,473	£91 5 3
June 7	213¾	£19,369	£90 12 4

Imports of Tin Concentrate at Liverpool.
Reported by H. A. Watson & Co.

	May, 1915 tons	Total, 1915 tons
Bolivia	3,956	18,007
Nigeria	292	2,888
South Africa	140	804

REVIEW·OF·MINING

INTRODUCTORY.—Political affairs both at home and abroad have obscured mining topics through the last month. The cabinet changes, focussing attention upon supply of munitions for war, have centred attention in mining upon copper, zinc, and lead. The first two have risen to unheard of prices and early in June lead began to climb. We discuss the ratio of demand and supply editorially. Without much doubt the increase in price in the main reflects war demand, but in the United States, at least, there is also a distinct improvement in general business. A country where, in the midst of discussion of the *Lusitania* incident, an issue of $65,000,000 of bonds for one railway system and of $25,000,000 for the Argentine was snapped up in one week, is not so depressed as financial writers have seemed to think. The virtual ultimatum to the warring factions in Mexico, followed by the retirement of Mr. Bryan from the American cabinet, seems to bring nearer the day when peace will be restored to the Southern Republic and mining may be resumed in that great area. There can be little doubt that any move made by the United States to restore peace in Mexico will now receive the hearty support of the leading South American nations as well as the approval of Europe. Indeed it is privately reported from Washington that the United States has reached an understanding with Argentina, Brazil, and Chile looking toward intervention, unless Mexicans act promptly, and policing of the country by a constabulary directed by the four Powers until such a time as Mexico shall be able alone to maintain order. Meanwhile the United States is making good the deficiency of lead due to closing of Mexican mines and nobody seems to worry greatly over the loss in silver output, though there is a thrilling story of Villa's cavalry chasing to the border a $200,000 shipment made to the United States by a Villa governor! The big gold mines throughout the world are working at full capacity.

TRANSVAAL.—The output of gold on the Rand during May was 737,752 oz., and in outlying districts 25,796 oz., making a total of 763,548 oz., worth £3,243,347. The number of natives employed on the gold mines at the end of May was 183,961, as compared with 186,941 at the end of April and 165,433 a year ago.

The Randfontein Central has issued 150,000 reserve shares at par, £1, to provide funds to meet ordinary capital expenditure, but details as to the nature of the requirements are not given. The so-called working profit for 1914 was £813,774, but no dividend was paid. During the three months ended March 31 the 'working profit' was £146,340. It is not stated where the new shares were placed, but probably the funds were provided by the parent company, Randfontein Estates, for it is not likely that shareholders or outsiders would subscribe at par, when shares are obtainable for 13s. in the open market.

The ore now being developed to the south of the 'water' dike in Witwatersrand Deep is of lower grade than that nearer the outcrop. Difficulty in keeping the ore mined up to average is caused by the hanging wall being much decomposed.

The Witwatersrand Gold Mining Co. (commonly known as Knights) owns a long strip of deep-level ground, between Knights Deep and Knight Central on the west, and Witwatersrand Deep on the east. The ore developed by means of the vertical shaft recently sunk at a point 3000 ft. south of the outcrop is of highly satisfactory grade, but the best is to the north of the shaft.

The annual statement of the Knight Central shows that the reefs so far exposed below the Simmer dike are unprofitable. For over a mile of development the average assay-value is only 2·7 dwt. per ton, and the parts containing ore of higher grade are so small and unconnected as to be not profitable to extract. The reefs above the dike were also patchy, and a large proportion has been left behind. This deep-level mine has yielded little return to shareholders. An attempt was made during the month to boom the shares, but the details published did not justify such action.

Operations at the Messina copper mine were seriously impeded by storms and floods during February. The pumping plant on the Zand river was demolished, as was also a portion of the railway connecting with Pretoria and Delagoa Bay. Conditions are now normal again. During April there was produced 1104 tons of concentrate averaging 40·8% copper, and 102 tons of matte assaying 54·9% copper. Mr. A. F. Kuehn, one of the technical committee of the company, is now at the property, with the object of reporting on the present position of the ore reserves. The bank overdraft has been greatly reduced and it is hoped that the remainder, £27,600, will be covered when the concentrate and matte now on the way to England are realized.

The shares of the Oceana Consolidated are to be written down again, this time from 10s. to 5s. In 1909 their par value was reduced from £1 to 10s. Debentures to the extent of £200,000 are to be created. None will be offered to shareholders at present, but the whole issue will be lodged as security for a loan up to £160,000. The company has a variety of interests, in Mozambique, West Africa, Egypt, Russia, and the Piccadilly Hotel.

Progress at the Magadi soda property in British East Africa is necessarily suspended owing to the war, for it is near the frontier of German East Africa, where fighting continues sporadically. The line connecting the deposit with the Uganda railway is completed. As regards the sale of the soda products, the board has found it desirable to erect works at various commercial centres for the conversion of the raw material into marketable commodities. Works of this character are in course of construction at Manchester and Calcutta.

RHODESIA.—The output of gold during April was worth £315,541, the highest monthly figure since October last. The Shamva shows a gross increase in the yield of £5150 and an increase in the yield per ton from 13s. 10d. to 15s. 8d. Otherwise the increase over March is accounted for by returns from a number of irregular producers.

The lawsuit brought by the Amalgamated Properties of Rhodesia against the Globe & Phœnix is set down for October 19, and counsel anticipate that the hearing will last for a month. As recorded elsewhere in this issue, the action is in connection with the ownership of lodes outcropping on the John Bull claims, as ruled by the apex law of Rhodesia.

The smelting operations at the Haut Katanga are being expanded, as may be seen from the monthly reports recently issued. The production of copper for January was 823 tons, February 974 tons, March 1040 tons, and April 1476 tons.

WEST AFRICA.—The output of gold during April was worth £149,978, as compared with £153,177 in March, and £131,697 during April 1914. The highest monthly output was £159,410 in October 1914. The April figures for Broomassie and Prestea Block A both showed decreases.

The final dividend of 5% brings the total dividend distributed for 1914 by the Abbontiakoon to 20%, absorbing £125,381. About half of this was provided out of the balance of undivided profit brought forward from 1913. The loan of £140,000, arranged three years ago with the Fanti Consolidated and the Gold Coast Amalgamated for the purpose of providing a new mill, has been liquidated all but £20,000, which will be repaid in monthly instalments of £1250 each. The reserves have been fully maintained, at 622,000 tons averaging 10⅓ dwt., and on the 12th level a new orebody has been disclosed. Arrangements have been made to increase the capacity of the plant from 11,000 to 15,000 tons per month. The percentage of recovery is high. During December last only 9d. out of 39s. 3d. was left in the residue.

AUSTRALASIA.—Though the issue of debentures by the North and South companies at Broken Hill was interdicted in London by the Treasury, the money was readily found in Australia. In fact the £200,000 required by each company was subscribed five or six times over. The Zinc Corporation has come into the Broken Hill lead-smelting combination, and has taken £100,000 capital in the Broken Hill Associated Smelters Proprietary Limited, as the new company owning the Port Pirie works is called.

The Amalgamated Zinc (De Bavay's) announces that Mr. H. W. Gepp has sold 7500 tons of zinc concentrate to American smelters. This raises the total of Australian concentrate sold in the United States to 93,000 tons, but a number, if not most of the contracts, have been of doubtful profit to the mines. Shareholders in the Amalgamated are warned by the board that the high cost of transport and the smelter deduction will largely reduce the advantage obtained by the present high price of the metal. There has been agitation in favour of increased zinc smelting in Australia, following enlargement of the lead smelting works. Desirable as it is that smelting should be conducted near the mines, we are forced to believe that Australian zinc smelting on a large scale would almost certainly prove a disappointment. At the North Broken Hill, it has been decided to restrict the production of lead concentrate in order to bring the output to the figure required by the new smelting company. For some time, therefore, mining and milling will be conducted on alternate weeks.

The report of the Golden Horse-Shoe for 1914 shows that the slight improvement in the yield characterizing the results for 1913 was not maintained, so that the resumption of dividends for 1913 has proved only temporary. The amount of ore treated during 1914, 284,496 long tons, was the greatest on record, but the yield per ton was only 27s. 4d., as compared with 29s. 6d. during 1913. The developments during the year fully maintained the reserve, the estimate on December 31 being 727,043, averaging 36s. 4d. per ton, as compared with 715,496 tons averaging 34s. 8d. the year before. In comparing the yield with the content of the reserve it is necessary to remember that the average recovery is 82%. During the year, No. 4 lode was developed on the 2900-ft. level. At the intersection of the cross-cut, the lode was 15 ft. wide, averaging 76s. 6d. per ton. To the north, the lode has been proved for 153 ft., averaging 135s. per ton, and to the south, for 102 ft., averaging 40s. 9d., the width in both cases being taken at 10 ft. A winze is being sunk on the lode to a point 120 ft. lower, where another level will be opened. This occurrence of richer ore at depth is distinctly interesting.

Two years ago the yield per ton at the Bullfinch Proprietary was officially estimated at 60s. and during 1913 the yield was 54s. 7d. Since then, the figure has greatly shrunk, and only 29s. 5d. was extracted during 1914. At the end of 1914 the ore reserve was estimated at 101,402 tons averaging 27s. 6d. per ton, as compared with 145,582 tons averaging 36s.

the year before. The boom of 1910-11 was judged to be unwarranted at the time, on such facts as were then disclosed; the results are evidently confirming the opinions of adverse critics.

What appears to be a new lode has been struck at the Mount Morgan, while driving between the Main and the Sugarloaf workings. For 42 ft. the average assay was 10 dwt. gold and 2⅔% copper.

The Mount Elliott company has acquired the copper mine of the Mount Oxide company, the purchase price being 90,000 shares of £5 each. It is only a short time ago that the control of the Dobbin-Cloncurry group was purchased, so that the policy of securing possible sources of copper ore is being actively pursued. The Mount Oxide property was developed by Mr. Edmund Davis and the Consolidated Gold Fields.

The transcontinental railway from South Australia to West Australia is being actively constructed, in spite of the war. About 900 men are on the western section and 1800 on the eastern section. There is difficulty in obtaining water but drilling along the line has developed a supply, though much of the water is salt or brackish. It is expected that through communication between west and east will be completed at the beginning of 1917.

The great influx of water at the Talisman mine has retarded development during the last few months, and in consequence the ore reserve is running short. It is hoped however that conditions will become normal before August, and that milling will not be interrupted. During the year ended February 28 last, 50,190 tons of ore was treated, for a yield of gold and silver worth £255,411, or £5. 1s. 9d. per ton; £120,750 was paid as dividend, being at the rate of 35 per cent.

INDIA.—The rich ore-shoot to the north of the auxiliary shaft in Ribblesdale's section of the Mysore mine continues strong in depth. On the 15th level from the shaft, 66 ft. of driving is in ore assaying 2½ oz. gold per ton over 5½ ft. This level is the deepest part of the mine and is 4700 ft. from surface on the dip.

CANADA. — Our correspondent from Vancouver sends an interesting letter on mining conditions in British Columbia.

At the Hollinger mine at Porcupine, small steel balls are now being used in one of the tube-mills, instead of pebbles, and it is stated that the capacity has been raised 50% thereby. At Cobalt, the water has been pumped from Cobalt lake and the mud is now being removed.

UNITED STATES. — Perhaps the most notable feature of the month was the decision against the government in its suit to compel dissolution of the United States Steel Corporation. The decision is to be appealed to the Supreme Court, but we doubt greatly whether that body will reverse the lower court that has heard the case. This evidently is the opinion also of the stock market, which rose on announcement of the decision. Business is gradually improving throughout the country. Crop prospects are excellent, and the balance of foreign trade continues to grow in favour of the United States. The copper mines are working at full capacity, and anything that can by any possibility be made to smelt zinc is at work. Lead prices have begun to rise, coal is going to the Mediterranean, and only the great iron and steel trade lags. The railways have begun to show improvement and to place equipment orders, and if the country can honourably stay out of the war, real prosperity should not be long delayed. Amalgamated stockholders have formally voted to dissolve the company around which so much history has centred, and the Anaconda is planning enormous extensions as usual. Demand for copper is leading to much reconstruction and enlargement, in fact, throughout the country. The Virginia Smelting Co., at Norfolk, is building a chloridizing plant for treatment of sintered product from the Eustis and other mines. The product

from Wedge 5-hearth furnaces will go to leaching vats for treatment by the Mackay process. Mr. Utley Wedge, who is consulting metallurgist, is also erecting hot wells, scrubbing towers, etc., to treat the gases from the blast-furnaces. E. C. Vigeon has recently gone to the plant as manager. The hearing in the suit of Minerals Separation against Miami Copper Co. for infringement of patents, at Wilmington, Delaware, has been concluded, but decision cannot be expected for some weeks.

At Cripple Creek the Roosevelt tunnel is to be extended to the Vindicator, and a further consolidation of large properties in the district is under discussion. An investigation of the affairs of the U.S.R. & R. Co., the so-called 'mill trust' that a dozen years ago produced much local heartburnings, is threatened. Why disturb the dead? We discuss elsewhere the Stratton's Independence and the sale of its properties to the Portland G. M. Co. The Bunker Hill and Sullivan M. & C. Co. presents an attractive report on the business for 1914, with earnings of $1,017,828, and dividends of $981,000. Ore reserves amounting to 3,708,281 tons are scheduled, while present production is at the rate of 440,819 tons per year. Manifestly the future of the great property is secure.

The Alaska Juneau will use the money from recent stock sales in New York to build an 8000 ton mill. Important shore rights were recently confirmed by litigation, but at the same time a part of the water rights previously held have been lost to the Ebner. The first river steamer left Lake Lebarge for Dawson on May 6, three weeks early. A slow trip was anticipated since, while the ice has gone, water was low.

MEXICO.—Mining matters are largely at a standstill, being forced aside by the greater interest in the political situation and the pressing necessity of feeding a hungry people. The game of living on loot seems to have come nearly to an end, the country is flooded with paper money, credit is gone, and none of the revolutionary chiefs has been able to establish himself as supreme. Carranza holds Vera Cruz, Zapata the City of Mexico, Villa most of the northern country. There are minor chiefs and would-be chiefs almost beyond number. On the ranches and in the villages there is still food, but in the cities there is serious shortage, and within a month many thousands will face actual starvation. Still Carranzista officials ship meat and grain out of Vera Cruz to the United States. The Yaqui Indians in the northwest have been on the warpath, and have killed three Americans. United States forces were sent to Guaymas prepared to take the field, but quick action by the Governor, Maytorena, quelled the Indians before they arrived. President Wilson has issued a plain statement calling upon the Mexicans to ignore if they cannot unite the warring factions, and to set up a government in Mexico City that the great powers can recognize. He adds that otherwise the United States will be constrained to decide what means it can employ "to help Mexico to save herself and serve her people." This announcement, followed shortly by resignation of Mr. W. J. Bryan from the position of Secretary of State, is interpreted to mean that the patience of Washington has about reached the breaking point. Certainly no one who knows America doubts that intervention will be brought about quicker by the starvation of the Mexican people than by interference with American trade or even the killing of a few Americans. If the United States does undertake to pacify the country now, the task will be easier for the delay. Import of arms and ammunition by the Mexicans will be vastly more difficult than two years ago, the country is exhausted as to credit and resources, and the people are tired of fighting. As the President says, the Mexican people will "hate as much as they fear

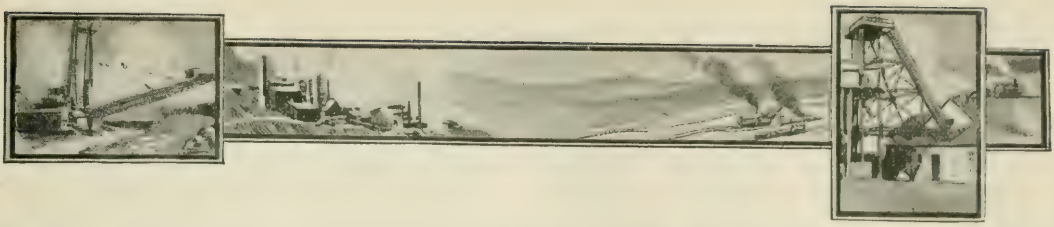
every man in their country or out of it who stands between them and their bread." It is also to be remembered that intervention now will be more readily justified in South America and other neutral countries than earlier in the war. Incidentally impending trouble in Mexico affords the best of shields under which to prepare for war in any quarter.

SOUTH AMERICA.—In Colombia, the Oroville is said to be doing better on the Pato ground and to be working in 60 c. gravel. Chile Copper has just started operations at Chuquicamata. Mr. Pope Yeatman cabled New York that the mill started as smoothly as could be wished. As the Chile anticipates an eventual output of 200,000,000 lb. per year, second only to Anaconda's production, the starting of the mill is something of an event, especially as this output will cost only 6 c. or possibly 5 c. per lb., or say £25 per ton.

CORNWALL.—The scarcity of labour and the unsatisfactory nature of much of it, continue to embarrass the mine managers. Mr. William James, of the Basset, had some bitter words to say on the subject at the meeting of shareholders. The Basset is in a bad way as regards development at depth, and a spirit of loyalty to the 'bal' on the part of the men is imperative if work is to be continued. On the return of the chairman, Mr. Francis Oats, from South Africa, the future policy will be thoroughly discussed.

CHINA.—The dilatoriness of Chinese government methods is to be blamed for the long period of inactivity of the Pekin Syndicate, and the final settlement of outstanding difficulties will presumably be the herald of a more successful era. The company was formed as long ago as 1897, with the object of securing rights to petroleum, coal, and iron deposits in the provinces of Shansi and Honan. Work has been centred on railway construction, and on the development of the coal deposits at Ja-Mei-Sen in Honan. For the last five years the annual output of coal has averaged 500,000 tons per year, and the profits accruing therefrom have been largely used for capital purposes. The agreement now made with the Chinese government removes many difficulties as regards the status of the various classes of shares, and also settles disputes as to competition with native coal-producers and the methods of marketing. A new company, called the Fu Chung Corporation, will be formed, the shares in which will be subscribed jointly by the Pekin Syndicate and the locally owned Chung Yuan Company. The coal interests of the two companies will be in the hands of the new corporation.

NOTABLE DEATHS.—Cornish mining lost one of its best friends when Thomas Bedford Bolitho died last month. Mr. Bolitho was the head of an old and capable family, and as a merchant, banker, smelter, shareholder in mining companies, and land-owner, he was keenly interested in the prosperity of the old county. One of his last acts in aiding the mining industry was to lend money to the mines during the period last autumn when tin concentrate was unsaleable.—In America the death of Franklin Guiterman is noted with sorrow. Born in the United States, educated at Freiberg, he was closely identified with smelting in Colorado. He was respected and liked even by the most partisan opponents of the Guggenheims, with whom he was associated. We remember him most kindly in connection with his long and effective service in the Colorado Scientific Society.—Sir George Farrar was one of the few Rand magnates of English birth. His parentage and breeding made him more than a dealer in gold and diamonds. He was also a soldier, a statesman, and a farmer. Sentenced to death by Paul Kruger for his complicity in the Jameson raid, he lived to form one of the staff assisting General Louis Botha in his campaign in German South-West Africa, and to die as the result of a railway accident while in that service.



EDITORIAL

PUBLICATION of a new edition of 'Who's Who in Mining and Metallurgy' has been postponed until the end of the war. Mr. George Safford, the editor, and his secretary are both at the front. The work will be completed promptly upon their return.

THE paper by the late J. J. Beringer presented at the last meeting of the Institution of Mining and Metallurgy on the physical condition of cassiterite in Cornish mill products, constitutes an important addition to the literature of ore-dressing. It will probably, in future, be regarded as his *magnum opus*. It is sad to think that these microscopical studies caused the eye-strain which induced his last illness. After reading his paper, we know what he meant when he told us at a meeting a year ago that a large proportion of the *minus* 200-mesh material went through the apertures three-abreast.

DIAMOND mining, while not active at present, is one of the world's great industries. In addition to the excellent description of the German fields by Mr. Boise that we present this month, we have a weighty contribution on Kimberley mining methods by Mr. Gardner F. Williams. It will follow with other articles on this industry. The great African mines are not working, as it is poor business to mine diamonds that the world is not prepared to buy, and the labour is more needed for the present in the gold mines. However, such diamonds as have reached the Antwerp market in the last few months have sold at a price distinctly above normal.

THE New York circuit court of appeals rendered a decision on June 4 in the case of Mr. A. Chester Beatty versus the Guggenheim Exploration Company relative to the possession of certain shares in the Yukon Gold Company and other emoluments claimed by Mr. Beatty. The finding of the lower court is reversed. In effect the court finds that the Exploration company was adequately informed as to Mr. Beatty's interest at the time the property was bought. Since further appeal, if any be made, can only be on law points, this settles all matters of fact, and sustains Mr. Beatty's contentions as to the conditions of the bargain.

ELSEWHERE in this issue Mr. M. T. Taylor describes the method adopted at East Pool for improving the separation of tin and wolfram by means of the magnetic separator. Another problem constantly confronting the mining man is the poor recovery of wolfram by water-concentration. In the dressing of deep-seated tin ores the recovery of cassiterite is not more than 66%, but probably the saving of wolfram in the same ore is not much more than 33%. Flotation has come to the rescue of sulphides, just as cyanide has reduced the margin of loss after amalgamation. Tin and wolfram still await a process supplementary to water-concentration.

WAR is producing shortage in unexpected quarters. A surprising one recently became evident in regard to sulphuric acid. An order for an amount that

in normal times would be considered almost trivial was refused early in June by dealers both in Great Britain and the United States, with the statement that there was no acid to be had. It is usually cheaper to ship the sulphur or sulphide to the point where acid is needed, than to store and ship the acid itself. Accordingly there is never any free stock at all comparable to the whole amount used.

RUSSIAN workmen are putting their money into savings banks instead of into vodka at a surprising rate. According to Mr. D. E. Kurilenko, manager for the State Savings Banks, the increase in deposits from January 1, 1914 to January 1, 1915 was 182,000,000 Rs., and for the first three weeks in April last was 33,000,000 Rs. The ministry is busy establishing branch banks in small towns all over the Empire. In the case of one such bank in a mining town, we are informed by the manager of the mines that the rate of deposit has increased more than 300 per cent. These figures, with those regarding increased efficiency of workmen that Mr. Purington gives in his interesting article on the Lena Goldfields on another page, speak volumes for what a sober, purposeful Russia means to the world.

LITIGATION over extra-lateral rights continues to be widely vexatious, though this month we may record the decision of two important cases. A third, that arising out of the Rhodesian law, has been again postponed. In the United States, the Supreme Court has affirmed on appeal the finding of the lower courts in the matter of the Stewart Mining Co. *versus* the Ontario Mining Co., which grew out of an attempt by the late F. A. Heinze to carry into the Cœur d'Alenes against the Bunker Hill & Sullivan company the warfare which, when waged against the Amalgamated at Butte, brought him fame and money. Heinze has gone and his case fails. At Tonopah the local court has ruled in favour of the West End company in contest with the Jim Butler of the Tonopah Mining Company. The case is noteworthy because law points were raised that have not previously been passed on by the courts, and the array of talent assembled assured a full presentation. The novel feature of the decision is that under certain conditions a vein may have extra-lateral rights in two opposite directions from the same apex. If this be sustained on appeal, the power for mischief of a sufficiently vexatious law will be greatly increased.

INVESTORS in London are being asked to subscribe to shares in the Alaska Hammond Syndicate Limited, which purposes to develop mining claims near Sitka. The matter is worth noting as illustrating the character of representations sometimes made in such cases. The estimates and descriptions of the property are unsigned, and rest therefore upon no special authority. Evidently the writer has confused the mines back of Juneau with those on Douglas island, as the description of the lode as "quartz in slate" does not correspond in fact to that of the Treadwell mines as is claimed. Also the estimated cost of 4s. per ton on a lode "20 ft. in width" finds no support in Treadwell experience where average costs are taken by Mr. F. W. Bradley at $1·40 and the lode is many times that width. As a matter of fact the veins known near Sitka are entirely different in character, being narrow and rich. Comparison of them with the large low-grade mines near Juneau is not likely to be convincing to anyone who knows the country. Incidentally the Alaska Hammond Syndicate has no relation to Mr. John Hays Hammond or to Mr. W. P. Hammon, as might possibly be hastily assumed by one having only a general knowledge of the mining activities of those practical and successful Americans.

War Prices and the Metals.

By the end of June the United States will be producing copper at its maximum capacity. Since the first of the year furnaces have been started up rapidly, but the time necessary to mine, mill, smelt, and refine copper has prevented the full effect being felt. Our New York correspondent discusses the situation in America from the point of view of one of the largest producers who frankly recognizes that the increased production is to meet the demand for metal in manufacturing munitions. This raises interesting questions as to quantities available. America can supply any reasonable amount of copper as fast as it can be used. Recognition of this fact is evidenced by the circumstance that the price of copper has not 'run away.' At the beginning of the year the American surplus stood at 41,800 metric tons. Taking production at 85%, which may be a trifle high, and local consumption for peace purposes as in 1914, which may be a little low, there would be in the first six months of the present year 205,845 tons remaining for export and for manufacture of munitions of war in the United States itself. But the normal peace requirements of countries other than Germany demand 79,000 tons, so that the copper available for making war materials was approximately 126,845 tons. This is assuming that by January there was no surplus not already ear-marked in the hands of the Allies and neutral European states.

In summary these figures would stand as below, stated in metric tons.

	Tons.
American surplus Jan. 1, 1915	41,800
Production for first six months at 85% of 1914 output of same period	323,038
Total	364,838
Domestic consumption as in first half of 1914	158,993
Exports as in 1913 except to Germany and Austria	79,000
Balance available for munitions	126,845
Total	364,838

If the whole 127,000 tons of copper were used for making brass, approximately 57,000 tons of spelter would also be needed, so it becomes important to inquire as to the amount of this metal available. With Germany and Belgium cut off, there is a shortage of 207,000 tons in the world's supply of spelter. This can only be made up by the furnaces of the United States, since they alone had considerable excess capacity available at the beginning of the war. Mr. W. R. Ingalls, of the *Engineering and Mining Journal*, has estimated this excess at 85,000 'short' tons of first-class capacity and 75,000 in old plants of second-rate efficiency. Roasting capacity is however behind distilling to the amount of about 175,000 tons, and maximum production necessitates the mining or purchase of calamine to that amount or an increase in roasting capacity. In view of present prices, and the fact that even the oldest and most uneconomical American furnaces are at work, it cannot be doubted that ore to feed the retorts will be available; indeed there is already a surplus of ore. Mr. Ingalls estimates that 517,000 tons of spelter may be produced in 1915. Mr. C. E. Siebenthal, of the United States Geological Survey, believes that as much as 600,000 tons can be produced by America in 1915, and gives the production for 1914 at 353,000 tons. This maximum production can hardly be attained before July. Normally the zinc industry in the United States is self-contained, neither exports nor imports being large. The increased output should therefore be all available for exportation or local use in making munitions, plus whatever may be drawn from consumption by higher prices. Of American spelter, roughly half goes into galvanizing, and at high prices some of this metal should be attracted. This diversion, however, proves to be less important than was anticipated. The amount of zinc used in galvanizing a black sheet is so small in proportion to the area covered, and the higher price adds so little to the final cost, that much zinc is still being used

to coat sheets, when it might well be spared. In England Henry R. Merton & Co. estimate the galvanizing trade as but 15% below normal. Mr. Siebenthal estimates American galvanizing at 90%, but taking it at 85, gives 48,000 metric tons for the year, or 24,000 for six months, of spelter freed. To this should be added perhaps 20,000 tons surplus at the beginning of the year, and the maximum increase available the first six months of 111,570 tons. Against this must be set one-half the normal German-Belgian exports, or 104,000 tons, and the estimated 57,000 tons necessary to join the surplus copper in making war brass. Summarizing these figures they stand as below, using metric tons:

	Tons.
Surplus at beginning of year	20,000
Amount freed by decrease in galvanizing	24,000
Maximum estimated increased production	111,570
	155,570
Normal German-Belgian exports	104,000
Amount needed for munitions	57,000
	161,000

Even most favourable assumptions thus indicate a shortage and the government is wise to have commandeered supplies. It will be the end of 1915 at best before spelter production is in proper ratio to copper on July 1, and even then this can only be brought about by most favourable circumstances. Any increase in copper production, it seems, will not help the munition makers, and a ready reason is afforded for the high London prices for spelter reached early in June.

Turning now to lead, somewhat different conditions prevail. Time was when lead was more important to soldiers than either copper or zinc. Less than a century ago the United States reserved from sale all lead-bearing lands in order to conserve supplies for the army. Now, through month after month of the world's greatest war, lead has continued to sell at peace prices, while copper and spelter have gone above the fondest dreams of producers. In modern warfare, lead is little used except to form the bullets with which shrapnel is filled. This is one reason for the low price. Another is that lead smelting is much better distributed than is that of either copper or zinc, and the battle lines have not so completely upset trade currents. Lead is generally smelted near its source of origin, and while Germany imported lead ores, it was not a large exporter of the metal. The leading sources of the world's supply are the United States and Spain, the two accounting for nearly 70% of the output. Both sources are freely open to the Allies. Lead is used so largely in building materials—paint, pipe, sheets, etc.—that it quickly reflects in price any stoppage of new construction. In 1913 a bad break in price in the United States was only averted by exports of 80,000 tons, an increase of 15,000, due to war orders from Russia (previously supplied from Germany) and by the deficiency resulting from the closing of Mexican mines. The New York price at the close of the year was 3·80 cents as against 4·11 at the beginning. Even so the United States increased its output 17%; which is not surprising since lead can be made in southeastern Missouri, the most productive district, for 2 cents per pound, and in the Cœur d' Alenes, according to the Bunker Hill & Sullivan Mining & Concentrating Company report for 1914, at 3·4 cents. Since January exports from the United States have increased rapidly. In March they amounted to 9170 tons as contrasted with 240 in March 1914. It is difficult to say what expansion would be possible under favourable conditions. Large reserves of ore are available, and an industry that adds nearly one-fifth to its output against falling prices and in the midst of a business depression, certainly has possibilities. There are signs, however, that lead is to follow copper and zinc to higher prices. Getting away from relative to absolute uses, the amount called for by the war is large. There can be little doubt that such surplus as existed at the beginning of the year has gone, and prices have

already begun to increase. Late in May the London price was £20. 15s. per ton, and at the end of the month it was £21. By June 11 it had risen to £28 and was going up £1 per day. It seems probable that it will go high. The immediate limiting factor is the refining capacity of British plants, and companies have already been notified that no more lead can be received for desilverization, for which a percentage of zinc is necessary. It is entirely possible that the "silver bullets" referred to by Mr. Lloyd George at the beginning of the war may become more real than figurative. Price disregarded, however, it is much easier to increase smelting capacity for lead than for zinc treatment. If any considerable increase in price holds through many weeks both Spain and the United States, to say nothing of minor or potential producers, may be expected to turn out quantities of lead that will soon bring it back approximately to normal figures. The interest is in the interim.

Stratton's Independence Limited.

The extraordinary general meeting of the shareholders held on May 17 was the occasion for bringing out a number of most interesting facts about the celebrated mine owned by this company. The story of the discovery, of the organization of the first Stratton's Independence Limited, of the over estimates, high prices of shares, and the disaster that followed is already familiar. In 1908, the lower levels had been fruitlessly explored and the upper levels were inaccessible because of a cave. A mill had been built to treat the accumulated dump ores, but the company was in debt locally to the amount of £25,000 and there was no working capital. Heroic measures were adopted. The company was reconstructed on a basis of £125,000 capital in 1,000,000 shares of 2s. 6d. each in place of £1,100,000 in £1 shares. The old shares were exchanged for new on a basis of 1s. 6d. paid, and thus cash to pay the debts and supply working capital was secured. Many of the shareholders had paid high prices for their shares, and the old company died with an unenviable record of failure. The mine, however, was good. To date it has produced gold to a value of £4,850,000 or $23,573,500. Of this, W. S. Stratton won before sale of the property $3,985,440, the first company produced $15,064,320, and the second or present company $4,523,740. The old company paid in dividends $4,748,989, while since its organization the new Stratton's has distributed 1s. 10½d. per share to which was added 6d. at the meeting. Thus, it has paid 2s. 4½d., nearly the par value of its shares, and has in reserve as a result of the action then take an sum equal to 1s. 3d. per share. On its merits as well as by contrast, these results redound greatly to the credit of the managers and the engineers in charge. The whole story indeed is a brilliant one of saving the maximum from a wreck. The total dividends paid by the two companies is materially above the net value of the mine, $5,000,000, as fixed by the examination made when British capital first went into the enterprise.

When the new company was formed, Mr. Philip Argall estimated a profit of $1 per ton when working at the rate of 10,000 tons per month on $3·60 ore. The profit has been substantially that amount despite the fact that the sampling of the dump by the engineers of the old company proved inexact, the ore averaging $3 instead of $3·60. Mr. Argall has been able to reduce costs and increase extraction enough to compensate. On the whole, the company has been fortunate in the amount of ore found in the upper levels, £65,000 having been won from the 'mill veins.' A good mine dies hard, but it dies. Mr. Argall has kept his company fully informed as to the exhaustion of both mine and dumps, and the time has come when the work must be stopped. Negotiations for purchase of other dumps, in particular those of the

Portland Gold Mining Company, proved fruitless, but they did result in an offer from the Portland company to purchase the mine and mill upon what are, we believe, excellent terms for all concerned. Briefly, the Portland is to pay £65,000 plus the invoice of supplies, and Stratton's Independence is to keep the property till the end of June. Since a surplus of £20,000 has been accumulated, the close of these various transactions will leave the company with nearly £96,000 on hand. This we believe to be very good business. Anyone familiar with the local situation will recognize that the Portland with its big dumps right at hand can pay a larger price for the Stratton's mill than could any other company. It is also true, owing to the relations of the two mines, that the Portland management can win whatever ore may still remain in the property at less cost than it could be mined by Stratton's working independently. The bargain is, we repeat, one of the satisfactory kind where each party to it takes a profit. We are confident that under the management of Mr. G. M. Taylor, the Portland will derive full benefit from the purchase, while the excellent record of service Mr. Argall has with Stratton's is the best guarantee that the fund now available will be wisely invested if the programme of purchasing another mine be followed. A small number of the shareholders at the meeting expressed a strong preference for dividing the whole sum remaining rather than making any new venture, however promising, at this time, but the vote was heavily in favour of the plan outlined by the directors. Mr. Argall stated to the meeting that, while his firm had four different properties under study, he was not prepared at this time to recommend a purchase. It was therefore left that until a satisfactory property was offered, matters are to stand as they are, and if no suitable investment be found within a reasonable time, the chairman agreed to recommend dissolution of the company. The policy or unpolicy of such reinvestment, made by a company as a whole in place of individually by shareholders, is too broad to discuss at this time. We may, however, congratulate the present shareholders of Stratton's on having received in dividends a sum substantially equal to the par value of their shares and having a sum in the treasury of the company adequate to undertaking a wholly new mining enterprise.

Studies of Slime.

Not all the activities of peace have been stopped by the war, and it is pleasant to record that the great technical societies are not only bearing their full burden of the duties incident to the conflict, but find time and energy to continue their work of preparation for the long future after the war. The May meeting of the Institution of Mining and Metallurgy is a case in point. It was pleasant, and we believe useful, to sit in the comfortable rooms of the Geological Society, and for the moment to push back into our sub-conscious selves the crowding thoughts of fellow members at the front, while considering the centuries-old problems of increasing our efficiency in mining and metallurgy. The subject for discussion was 'The Physical Condition of Cassiterite in Cornish Mill Products,' and the paper, a posthumous one based upon research of J. J. Beringer, was presented by Mr. W. H. Trewartha-James with a clearness and charm that would have lent interest to matter of much less intrinsic merit. In very fact Beringer's studies went to the root of things. It has long been known that concentration of cassiterite in Cornwall was imperfect and that the heavy loss was in the finer materials. What Beringer did was to enter, survey, and stake out the wide field of *minus* 200-mesh. He gave sharpness of definition to previously vague ideas, and Mr. Trewartha-James emphasized his results by happy phrasing and apt illustration. It is apparent that there are

degrees of fineness that are measurable, and possible fields for sharp division, in making recovery even in *minus* 200-mesh material. The first essential to improvement is the determination of the exact facts, and the next the limitation of the field that seems for the moment hopeful. This Beringer did. We must refer to the original paper for the details, but we would join in paying tribute to the patient industry and scientific spirit of the man who has laid a foundation upon which others may build. Seeing the problem accurately is half the task, and that has now been accomplished.

Colony or War Base.

German South-West Africa has recently been brought sharply before public notice by the dramatic announcement of the entrance into Windhoek, its capital, of the forces under General Louis Botha. In a general way the world has known that a campaign was in progress in that territory as well as in Flanders and Galicia, but the distance to the field, the relatively small number of men involved, and more than all else the enormous interest of the great contest going on at the front door of Europe, has distracted attention from the real extent and significance of the African campaign. There was even impatience, in neutral countries, that white men should be fighting among themselves in the black continent since the fate of the war was certain to be decided in Europe. That the abortive rebellion in the Transvaal had been stamped out and that local forces were taking some sort of action against the Germans who were credited with having instigated the revolt, was about as much as many people knew of the matter. Nevertheless, in certain important particulars the contest in south-west Africa went more to the heart of matters than the warfare in Europe, and in the difficulties of the work and the skill and dash of the fighting, the work done by the South Africans does not suffer by comparison with that of the Belgians and English in Flanders, the Canadians and French in France, the Russians in Poland and Galicia, or the French and Colonials on the Gallipoli peninsula. The manner of this country in which the fighting has been in progress, and for which it has been waged, is told in the excellent account of the 'Diamond Fields of German South-West Africa' contributed to this number of the *Magazine* by Mr. Charles W. Boise, of the staff of the Société Internationale Forestière et Minière du Congo. Mr. Boise, himself engaged in development of diamond fields in the neighbouring Kasai district of the Congo, visited the area last July and writes sympathetically of the difficulties that were faced and overcome by the German engineers in developing this, the second great mineral industry in the colony. If the difficulties in time of peace were so great, it can well be imagined what they have proved when in addition the British expeditionary force had to meet the full strength of a well prepared and well equipped military defence. It will probably be long before full details of the campaign become known, but in the *Atlantic Monthly* for May, Mr. Cyril Campbell contributes a vivid account of the perils and hardships of the first stage of the advance, from Lüderitz to Aus. Beyond the coastal desert in which the diamond fields lie, is a fertile upland which, while it needs irrigation, is capable of considerable agricultural development, and it is in this area, fenced off as it is from the Transvaal and the Cape by another sandy waste, that the principal German settlements lie. To the north at Tsumeb, is the Otavi copper mine, from which in the year 1913-14 was produced 50,000 tons of ore, containing 13% copper, 23% lead, and 7·7 oz. silver per ton. The Otavi, by the way, while owned by a German company is an Anglo-German enterprise, a considerable portion of the shares being held in London. The diamond field and this mine constitute the two important mineral

developments as yet made in the territory.

To understand why the British and Boers of South Africa have made prompt and common cause against the Germans of the South-West, and how this contest goes to the centre of things, it is necessary to go back a bit to things as they were before the war. Germany has made plea for 'a place in the sun.' Official spokesmen for Germany, while professing a preference for the 'open door' in international trade, have maintained that wherever any part of the still remaining unappropriated part of the world was taken by any colonizing power, it was necessary, in order to protect Germany's share of the world's trade, that compensation should be given by allowing her to segregate an equivalent part of the world's public domain as an exclusive field for German enterprise. It was on this basis rather than any large local interest already developed, that Germany based her demand for compensation in the Congo when France took Morocco. Furthermore, recognizing the fact that Germany did not attempt to become a factor in international trade until after other countries had pre-empted the best areas for Colonial expansion, persistent propaganda was supported looking toward a readjustment of colonies so that Germany might have a 'fair' share. Thus Hans Delbrück, writing in the *Preussische Jahrbucher* in 1912, has suggested as a feasible and proper solution of the situation in Africa that the French Congo, the Belgian Congo, and Portuguese Angola should pass to Germany, thus forming a self-contained German empire. Regarding this he further says, "We are justified in accepting this rearrangement as a fairly certain element in our views of the future," and in January of this year he reproduced this as representing a part of Germany's terms of peace. Such statements, coming from such an authoritative source, and they are but typical, constituted a virtual threat. This was strengthened by the fact that in the area actually controlled by Germany, the larger preparation seemed always for war, rather than for peace. In German South-West Africa the annual grant of the Reichstag of £2,000,000 has been spent almost exclusively in converting the country into a great war camp. There were no harbour works of note, no wharves, and no public buildings, but there were strategic railways, roads, and trails nicely adapted to give military forces within the colony a good start toward neighbouring territory, but not designed for service to invaders. Forts, block-houses, lines of communications, big guns, aeroplanes, and all the equipment of war was assembled in time of peace. There were about 10,000 trained white troops, which with reservists gave a force of 16,000 or more, aside from three native corps. All this converted a potential threat into an actual one, and South Africans began to foresee a condition under the principle of armed neutrality, when no one in Africa would have time to farm or to mine, because he must watch his neighbour. This was resented deeply, just as the United States maintains the so-called Monroe doctrine, not because of any selfish purpose to absorb all the area or trade of the western hemisphere, but because the intrusion of a different system would throw unwelcome burdens on her own people. The South Africans noted the presence of big guns, and other war equipment in the German colonies that could be used effectively only in a fight with organized white forces. They also credited their German neighbours with a persistent campaign to array a part of the Boers against the existing government, and they saw in this a deliberate purpose to expand at their cost. When the war broke out, the anticipated attempt to bring about rebellion in the Union of South Africa was made, and there has been no denial that it was instigated by the Germans. Recalling also the proposal, as voiced by Delbrück, that Angola and the Belgian Congo should go to

Germany and link up the eastern and western colonies of the Empire, note that the first act of the war in Europe was the seizing of Belgium by Germany and that in Africa, coincidently, German troops made a foray into Portuguese territory, though there has been to this day no declaration of war as between Germany and Portugal. Apparently, the South Africans were right, and the German colony was less a colony than a military base for winning colonies.

The suggestion has been made that the British invasion of German South-West Africa was a "typical" case of seizing territory that could not for the moment be defended, with a view to being in possession when the war should end; that in fact the motives were commercial rather than broadly patriotic. It is, however, to be remembered that, wisely or unwisely, the British had earlier refused to include the territory in question in the Empire, being content to hold Walfish bay against the very contingency that has arisen—the territory being converted into a danger to neighbouring British states. It is true that German industry had built up valuable holdings in what had been a waste field, and that competition, in diamonds for example, would cause much anxiety in British circles. The total value of the diamond field, however, is not large. According to Mr. Boise, the number of white men employed was only equal to about 5% of the regular white troops in the area, and, including the blacks, the total was less than one-third of the effective white fighting forces. Such figures give one a measure of the German estimate of the relative value of peaceful industry and war preparation. If the diamond fields were allowed to produce and sell at their maximum, they could not dominate the market and their life was sure to be brief. The only time the Diamond Syndicate took notice of them was when it tendered for the annual output. The net result was that the Antwerp buyers paid a higher price, so that the action of the Syndicate was to the benefit of the Germans. The thesis that the British were actuated by commercial motives cannot be sustained. It was fear of extension of the German military system that roused South Africa. The world has no deep set purpose to destroy Germany, and even the countries now at arms with that country recognize the value to the world of the German skill and industry in peace. When the war ends, we believe that international commerce and trade alliances will be rebuilt at a rate that now seems out of the question, but a feudal state in the midst of Europe is no longer possible and the burden of armed peace must be lifted. Unless that be accomplished in Europe, and the spread of the system to other continents be prevented, the war will have been fought in vain. The South Africans have got at the heart of the matter quickly, effectively, and unostentatiously, and they deserve the congratulations they are now receiving.

Explosives and Dyes.

At the present time, when immense quantities of nitro-explosives are required by the belligerent nations and when British and American chemists are seeking to establish home industries for the manufacture of the dyes hitherto obtained from Germany, it is natural that the thoughts of many of our readers should be diverted from mining and metallurgy and centred on either of these two departments of technical manufacture that promise greater material advantage. Judging by the number of inquiries by word of mouth and by letter, interest on the part of mining men and metallurgical chemists in the production of explosives and dyes is by no means inconsiderable.

At first sight there might appear to be no connection whatever between nitro-explosives and dyes. Indeed, the United States Bureau

of Mines has been the butt of much foolish criticism for its announcement of a discovery by Dr. Walter F. Rittman, which it is hoped may become of commercial value, whereby both can be prepared from petroleum, the critics holding that such a claim savours of the universality of the inventor with an unbalanced mind. As a matter of fact, the formation of both nitro-explosives and dyes is based almost entirely on the introduction of nitrogen into organic compounds of carbon and hydrogen, or carbon, hydrogen, and oxygen. In the case of explosives, nitrogen is absolutely the controlling element, while as regards the coal-tar dyes there are few exceptions to the rule that nitrogen enters into their composition, a notable exception being alizarine, or artificial turkey-red. There are four main classes of nitrogenous compounds used commercially: fertilizers, explosives, artificial colours, and drugs and poisons. It is one of the remarkable facts of chemistry that nitrogen, though in itself the most inert of gases, is the vital principle of many groups of substances possessing unusual strength and power. In the case of explosives, nitrogen plays the chief part in gunpowder, black powder, ammonia compounds, and nitrates, as well as in the nitrated organic compounds. The fact that nitrogenous compounds are required as fertilizers for plant-life shows that nitrogen enters into the composition of many vegetable extracts and products, and the vegetable dyes of a previous generation were largely nitrogenous. Thus the first step to be taken by the research chemists who desired the production of artificial nitrogenous vegetable compounds was the nitration of a hydrocarbon. The first compound to be nitrated was benzene, C_6H_6, from which nitro-benzene, $C_6H_5\ NO_2$, and aniline or amido-benzene, $C_6H_5\ NH_2$, were produced. But dyes were not the only vegetable compounds sought, and, in fact, most of the earlier experiments had for their object the production of such things as drugs and perfumes. Perkin's historical discovery of mauve as a derivative of aniline was accidental, for he was at the time trying to synthesize quinine. Many other constituents and derivatives of coal-tar have been nitrated. For instance, carbolic acid, or phenol, $C_6\ H_5\ OH$, yields picric acid, $C_6H_2\ (NO_2)_3OH$, three atoms of hydrogen being replaced by the radical NO_2. Both aniline and picric acid are the parents of multitudinous dyes, while picric acid is used as an explosive under the names of lyddite and melinite. Another of the coal-tar compounds known to the general public is toluene. This is in chemical terminology methyl-benzene, one of the atoms of hydrogen in benzene being replaced by the methyl radical $C\ H_3$. If this is treated with nitric acid for the substitution of three other of the hydrogen atoms by the nitric radical, we get tri-nitro-toluene, $C_6\ H_2\ CH_3\ (NO_2)_3$, the explosive used in German shells. These few instances serve to show the intimate connection of dyes and explosives as derivatives by nitration of constituents of coal tar. We have referred to the new process for producing benzene, toluene, and other compounds of the aromatic series from petroleum, and incidentally for increasing the yield of petrol, announced by one of the technical staff of the United States Bureau of Mines, Dr. Walter F. Rittman. The process is now being tested on a commercial scale by one of the leading firms of explosive manufacturers in the United States, and arrangements are nearly completed for testing its application for the production of petrol. Pending the publication of the results of these tests and of the complete technical details, it is difficult to judge the value of the discoveries. It is known that many petroleums contain small quantities of benzene, toluene, etc., but their recovery has not so far been generally advantageous. Heavier hydrocarbons of the benzene series, such as naphthalene and anthracene, have been prepared from petro-

leum residue and from bitumen by carbonizing, in much the same way as coal is treated in gas or coke manufacture. Dr. Rittman's process does not, we understand, involve simply the extraction of existing benzene from petroleum, but rather the production of new compounds by the application of the familiar cracking process to material at unusual temperatures and pressures. Having investigated the temperature-pressure curves of petroleums at temperatures not previously used in actual tests and studied their 'critical' temperatures, he is said to have found that beyond certain temperatures further heat does not result in an increase of pressure. Instead, slight changes of temperature make large changes in the structure of the molecules, and the heavy oils are readily cracked, to produce the light ones. The distillation is conducted in steel tubes at fairly high temperatures, and no doubt many practical difficulties are involved. However, seeing that a sum of $200,000 has been provided for the purpose of testing the process on a large scale, and that a force of experienced refiners is busy under the direction of Dr. Rittman, we can at least anticipate a prompt determination of the question as to the economic value of the process. If it prove successful a ready means is afforded for supplying the enormous amounts of toluene and so the trinitro-toluene necessary to any abundant supply of high explosive shells. Incidentally we may mention that in Great Britain the problem of an adequate supply of toluene has already been solved. Works have been in operation for some weeks and others are rapidly being converted to the new use. We regret that motives of public policy prevent our saying more at this time than that the discovery that has made this possible was the outgrowth of research by metallurgical engineers engaged in solution of problems in their own industry. It is a pleasure to record the fact that in this vital matter our professional associates have rendered such important service.

Furthermore it is interesting to note that the phenomena in connection with the presence of compounds of the benzene series in petroleum and their production by the distillation of petroleum residue have some bearing on the study of the origin of petroleum. Some theorists are of opinion that petroleum is formed by the distillation of coal by access of the earth's heat through the agency of igneous intrusions. By such a reaction the production of the benzene series would be expected, and the fact that a large proportion of the petroleum produced throughout the world consists almost entirely of the paraffin series is not favourable to the theory. Petroleum and the individual members of the paraffin series are singularly unresponsive to the efforts of the research chemist. They cannot be induced to nitrate or to saponify, and therefore are not bases for the explosive, dye, or soap industries. Before leaving the subject of the benzene derivatives, we may mention that the production of artificial colours has strayed a long way from the original intention of the early researches, which was, as we have stated, the synthetic manufacture of known vegetable dyes. As a matter of fact, madder and indigo are the only two natural colours that have been produced artificially, and all the other coal-tar colours were previously unknown. The facts presented in this short article will serve to indicate briefly the connection between certain nitro-explosives and the coal-tar colours. These explosives, however, are only a small proportion of those used in warfare, and few of them are employed in mining, nitro-benzene as used in the composition of roburite being the most notable. By far the greatest proportion of nitro-explosives come under the classes of gun-cotton and nitro-glycerine, made by the nitration of cellulose and glycerine. On another occasion we intend to review the general position of explosives as applied to warfare and mining.

PERSONAL.

W. T. ANDERSON is with the Australian Expeditionary Force.

PHILIP ARGALL has returned to Colorado.

A. CHESTER BEATTY has removed his New York office from 71 Broadway to 25 Broad Street.

CLINTON P. BERNARD passed through London on his way to Greenland.

J. E. BREAKELL has returned to London from Honduras, where he has been manager of the Socorro gold and silver mine for the past three years and a half.

J. M. CALDERWOOD is expected in London.

THOMAS CANTLEY, manager for the Nova Scotia Steel Company, is in Petrograd.

H. T. CURTIS is with the London Divisional Engineers, at Harlow, Essex.

S. D. DAY is 2nd Lieutenant in the 201st Field Company of the Royal Engineers.

W. H. DAWE has been elected president of the Transvaal Chamber of Mines.

F. G. DUNNING has been appointed manager of the Sub-Nigel, at Heidelberg, in the Transvaal.

A. M. FINLAYSON has been gazetted to the 10th Service Battalion of the South Lancashire Regiment.

GWYNN G. GIBBINS has arrived from Canada to join the Royal Engineers.

E. M. HAMILTON has gone to San Francisco.

H. S. HARGER has joined the Imperial Light Horse, and is serving in German South-West Africa.

A. L. HAY is manager of the Bullfinch mine in West Australia.

W. L. HONNOLD left Johannesburg at the end of May on his resignation of the chairmanship of the Brakpan and Springs Mines, and will return to the United States.

A. MCARTHUR JOHNSTON is here from Johannesburg on holiday.

W. H. LANAGAN has returned to San Francisco from Nicolaievsk, in East Siberia, by way of Japan.

J. A. MACTEAR has retired from the firm of W. R. Feldtmann & Co.

BENJAMIN MAGNUS, on retiring from the positions of general manager for the Mount Morgan Gold Mining Co. and consulting engineer for the Electrolytic Refining & Smelting Co., intends to travel through the Far East on his return to the United States. His address in New York will be care of H. M. Toch, 320 Fifth Avenue.

A. H. MCDONALD, of Butte, is now at the Rio Tinto company's smelting works.

W. W. MEIN has been in San Francisco.

C. W. MERRILL was in New York recently.

FRANCIS NICHOLSON is at Vinton, Texas.

P. N. NISSEN has been transferred from the Sherwood Foresters to the Royal Engineers.

W. H. LOVELETT, A. M. PETERSON, and W. G. PATTISON have been here from the Belgian Congo.

R. E. PALMER has returned from a short visit to Spain.

E. W. PARKER has resigned from the United States Geological Survey to assume charge of the statistical work of the Anthracite Coal Operators of Pennsylvania. He is succeeded as chief of the division of mineral resources by H. D. McCaskey.

G. S. PATERSON is with the Royal Garrison Artillery at Hartley, Northumberland.

N. W. PIRRIE is here from Vancouver, and has obtained a commission in the Royal Horse Artillery.

R. W. PRINGLE has been appointed consulting engineer to Central Rhodesia, Limited.

ROBERT RAINE is manager of the Village Main Reef mine.

F. A. D. RICHMOND is 2nd Lieutenant in the 200th Field Company of the Royal Engineers, and is at present stationed at Morecambe.

LINCOLN C. ROGERS has a commission in the Army Ordnance Corps.

DUNCAN S. SMITH and JAMES R. EVANS have been in London on their way to the Kasai diamond fields of the Belgian Congo.

JOSEPH TEMPERLEY has been co-opted to the board of directors of A. Goerz & Co., and appointed chairman.

E. C. VIGEON is manager for the Virginia Smelting Co., West Norfolk, Virginia.

A. J. WALTON is manager of the Rose Deep mine, in the middle east Rand.

RUSH J. WHITE has retired from the staff of the Federal Mining & Smelting Co., but will remain at Wallace, Idaho, in consulting work.

H. C. WILMOT has left the Philippine Islands, and is now at Baker City, Oregon.

H. M. WILSON has resigned from the U.S. Bureau of Mines to assume charge of a general safety bureau organized by companies offering workmen's compensation insurance.

A. M. YONGE has returned to Mina La Union, Costa Rica, from a visit to the United States.

METAL MARKETS

COPPER.—There is little variation to record in prices at the beginning and end of May. The market has presented a steady appearance, which little accords with the briskness of the demand. Contracts have been placed for substantial quantities for delivery over the whole of next year, and some mine-owners have taken advantage of the demand to clear out their production well ahead. Prices would probably have responded more freely, but for uncertainty as to America taking a hand in the present conflict, for the free buying points strongly to higher prices. The American domestic demand is assuming large proportions, and the increased and still increasing production of the metal shows no sign at present of outstripping the power of consumers to absorb it. Apart from the demand for war purposes, the general trade outlook in America is good, and the future invites confidence. Shipping facilities from America are more plentiful, and some copper has been put into warehouse in this country. This will make for steady markets without impairing their strength. Apart from munitions a good deal of general manufacturing business is reaching this country. The difficulty is the absence of labour to cope with the work to be done.

Average prices of cash standard copper: May, 1915, £77. 14s. 3d.; April, 1915, £75. 3s. 5d.: May, 1914, £63. 5s. 10d.

TIN.—The market has been lethargic in face of favourable statistics and of a good demand. A lead is wanted toward higher prices, and since the present level is very close to the cost of production we should not have to wait long for a leader with the needful courage. American stocks are small, and the demand is good, but buying has been rather spasmodic. Russian demand has not developed as was hoped, but this is to be attributed to the difficulties of inland transit from the ports. With the opening of the Dardanelles we shall doubtless witness a revival of Russian trade, and a more favourable exchange to help it. The Scandinavian demand has entirely ceased under our Government's discouragement. English consumers have been inactive, although the demand for tinplates is good. A rise in the price would no doubt send them on the market for heavy quantities. The Banca accumulation is being held in Java until the end of the war. It is long since the course of prices in London has presented such an uninteresting appearance.

Average prices of cash standard tin: May, 1915, £162. 18s. 6d.; April, 1915, £166. 10s. 0d.; May, 1914, £150. 19s. 3d.

LEAD.—Prices showed a sagging tendency till toward the end of the month. Large shipments of American lead have been reaching this market, and have impressed dealers with the view that the metal was being pressed for sale. It seems, however, to have been the result of accumulation following the freight stringency of previous months. Dealers were also disappointed at the poor demand from Russia, and the general discouragement of business in metals with neutral countries in official quarters. With the entry of Italy into the conflict, a heavy demand has again sprung up, and purchases for Russia in America were reported. Animation was put into the market late in the month by a rise in the American quotation. The reason is not quite apparent for the increase to 5½ cents, far above the London parity, but successive leaps within so short a period are not justified by anything that is known on this side. The failure of Mexican bullion which is given as the cause is not sufficient. Consumers have unfortunately been caught short in face of plenty, for recent arrivals have been large.

Average prices of good soft pig lead: May, 1915, £20. 7s. 2d.; April, 1915, £21. 2s. 1d.; May, 1914, £18. 4s. 8d.

SPELTER.—This market has become wild and panicky. In spite of the quietness in the galvanizing trade, the demand for the metal cannot be satisfied. The British Government has accordingly commandeered supplies except for ammunition. It is not apparent as yet how this will help. The acuteness of this scarcity is brought about in part by the absence of skilled labour, and by the inaction of the authorities in failing to encourage the smelting of the large quantities of concentrate seized and now lying in this country. With increasing demand on all sides the further course of the market cannot be judged. The need is so great that the price is just governed by the conscience of the holder. Drastic measures are imperative to control the market, and the department responsible should be encouraged to take them.

Average prices of good ordinary brands: May, 1915, £67. 19s.; April, 1915, £49. 17s. 9d.; May, 1914, £21. 5s. 9d.

SILVER.—The market has been dull and devoid of special feature during the last month, and the price has shown little variation, at about 23½d per standard ounce.

ANTIMONY.—The price continues to advance steadily and the quotation for English brands is now from £115 to £125; a rise of £15 during the month. The only free source of supply is China.

QUICKSILVER.—Spanish quicksilver is now quoted at £14 per flask, a rise of £2 during the month.

PLATINUM.—185s. per oz., nominal.

BISMUTH.—10s. per lb.

COBALT.—96 to 98%, 7s. 6d. per lb.

ALUMINIUM.—£100 to £105 per ton.

NICKEL.—£210 per ton.

MOLYBDENUM.—The demand for molybdenite is not so pressing as a month or two ago, and the price has slackened slightly, standing at 115s. per unit containing 90% MoS_2. Ferro-molybdenum, 18s. per lb. of molybdenum contained.

IRON.—The prices of pig iron have hardened slightly, No. 3 Cleveland being quoted at 66s. per ton and Cumberland hematite at 95s. Rubio (Spanish) ore is quoted at 27s. delivered.

CHROMIUM.—Chrome ore, 40 to 50%, 75 to 90s. per ton. Ferro-chrome alloy £25 to £35 according to amount of carbon present.

FERRO-VANADIUM.—33 to 40% vanadium, 9s. per lb. of vanadium in the alloy.

FERRO-SILICON.—£11 to £15 per ton.

FERRO-TITANIUM.—15 to 18% titanium and 5 to 8% carbon, 6½d. per lb. flat price.

TUNGSTEN.—Prices of wolfram have advanced, 40s. per unit being quoted for ore containing 65% or over of WO_3; scheelite, 70% WO_3, 39s. per unit Tungsten metal, 96 to 98%, 6s. per lb.; ferro-tungsten, 5s. per lb. of tungsten contained.

MANGANESE.—Little or no new business is done in manganese ores. The price for Indian ores 50% is nominally at 1s. 8d. per unit. Ferro-manganese has advanced to £20 per ton.

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	May 3 1915	June, 1915
RAND:			
Bantjes	14	10	10
Brakpan	51	52	52
Central Mining (£12)	160	137	135
Cinderella	6	4	4
City & Suburban (£4)	52	47	46
City Deep	66	64	63
Consolidated Gold Fields	43	32	30
Consolidated Langlaagte	35	36	35
Consolidated Main Reef	18	19	19
Crown Mines (10s.)	120	94	86
D. Roodepoort Deep	17	17	18
East Rand Proprietary	33	32	31
Ferreira Deep	47	50	46
Geduld	23	27	31
Geldenhuis Deep	26	22	21
Gov't Gold Mining Areas	23	22	21
Heriot	55	62	65
Jupiter	5	7	6
Kleinfontein	24	26	25
Knight Central	8	5	9
Knight's Deep	35	21	25
Langlaagte Estates	20	18	18
Luipaard's Vlei	10	8	8
Main Reef West	7	8	7
Meyer & Charlton	115	107	107
Modderfontein B	89	96	100
Modder Deep	58	77	86
Modderfontein, New (£4)	263	289	294
Nourse	27	23	26
Rand Mines (5s.)	120	100	98
Randfontein Central	17	14	13
Robinson (£5)	57	35	34
Robinson Deep	33	26	26
Rose Deep	43	36	36
Simmer & Jack	12	8	8
Simmer Deep	1	1	1
Springs	11	24	23
Van Ryn	67	61	60
Van Ryn Deep	47	51	53
Village Deep	40	38	37
Village Main Reef	40	31	32
Witwatersrand (Knight's)	71	62	62
Witwatersrand Deep	48	35	34
Wolhuter	14	13	14
RHODESIA:			
Cam & Motor	19	15	15
Chartered	17	12	11
Eileen Alannah	11	9	9
Eldorado	18	15	14
Enterprise	9	6	6
Falcon	14	11	11
Giant	14	8	7
Globe & Phœnix (5s.)	32	31	27
Lonely Reef	27	22	22
Shamva	46	37	37
Wanderer (5s.)	3	1	1
Willoughby's (10s.)	7	6	6
OTHERS IN SOUTH AFRICA:			
De Beers Deferred (£2 10s.)	330	237	237
Glynn's Lydenburg	11	10	10
Jagersfontein	78	62	57
Premier Diamond Defer'd (2s. 6d.)	152	100	97
Sheba (5s.)	4	4	4
Transvaal Gold Mining Estates	37	39	36
WEST AFRICA:			
Abbontiakoon (10s.)	8	9	9
Abosso	14	9	9
Ashanti (4s.)	16	16	15
Broomassie (10s.)	2	2	1
Prestea Block A	15	13	12
Taquah	15	15	14
WEST AUSTRALIA:			
Associated Gold Mines	7	5	5
Associated Northern Blocks	7	5	4
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	49	46
Great Boulder Proprietary (2s.)	14	15	16
Great Boulder Perseverance	2	2	1
Great Fingall	9	6	5
Ivanhoe (£5)	50	45	44
Kalgurli	36	34	36
Sons of Gwalia	23	15	17
Yuanmi	3	2	2

GOLD, SILVER, *cont.*	July 1 1914	May 3 1915	June 1 1915
OTHERS IN AUSTRALASIA:			
Blackwater	16	12	15
Consolidated Gold Fields of N.Z.	13	12	12
Mount Boppy	10	12	12
Mount Morgan	52	49	46
Progress	10	7	7
Talisman	33	24	22
Waihi	42	45	40
Waihi Grand Junction	25	25	23
AMERICA:			
Alaska Treadwell (£5)	162	146	144
Buena Tierra	15	13	13
Butters Salvador	20	10	15
Camp Bird	9	6	5
Canadian Mining	—	9	9
Casey Cobalt	13	12	11
El Oro	14	8	7
Esperanza	15	8	7
Kirkland Lake Proprietary	74	31	30
Mexico Mines of El Oro	97	79	72
Oroville Dredging	10	12	12
St. John del Rey	15	15	15
Santa Gertrudis	11	7	7
Tomboy	22	24	24
Tough-Oakes	28	14	9
RUSSIA:			
Lena Goldfields	43	39	36
Orsk Priority	7	9	8
INDIA:			
Champion Reef (2s. 6d.)	11	12	11
Mysore (10s.)	93	86	85
Nundydroog (10s.)	27	26	25
Ooregum (10s.)	23	25	25
COPPER:			
Anaconda (£5)	126	154	131
Cape Copper (£2)	60	62	62
Chillagoe (10s.)	1	½	½
Cordoba (5s.)	6	3	4
Great Cobar (£5)	3	2	2
Great Fitzroy (5s.)	½	¼	¼
Hampden Cloncurry	27	25	25
Kyshtim	55	53	47
Messina (5s.)	15	10	10
Mount Elliott (£5)	55	65	59
Mount Lyell	23	25	25
Rio Tinto (£5)	1355	1240	1192
Sissert	25	24	21
South American Copper (2s.)	22	14	15
Spassky	52	50	51
Tanalyk	78	52	47
Tanganyika	40	28	26
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	28	23	20
British Broken Hill	36	26	24
Broken Hill Proprietary (8s.)	36	43	42
Broken Hill Block 10 (£10)	32	24	22
Broken Hill North	52	45	42
Broken Hill South	175	151	145
Sulphide Corporation (15s.)	26	20	19
Zinc Corporation (10s.)	19	14	14
ASIA:			
Burma Corporation	28	39	37
Irtysh Corporation	—	39	36
Russian Mining	31	21	18
Russo-Asiatic	151	110	100
TIN:			
NIGERIA:			
Bisichi	8	8	6
Jos (5s.)	5	5	4
Kaduna (5s.)	15	15	15
Naraguta	17	17	16
N. Nigeria Bauchi (10s.)	3	2	2
Rayfield	5	5	4
Ropp (4s.)	100	17*	17*
OTHER COUNTRIES:			
Aramayo Francke	31	27	27
Briseis	5	6	5
Cornwall Tailings	17	15	15
Dolcoath	11	9	7
Geevor (10s.)	5	5	4
Gopeng	27	30	30
Mawchi	20	2	2
Pahang Consolidated (5s.)	7	8	7
Renong Dredging	36	21	21
Tekka	55	60	60
Tronoh	26	31	30

* Denomination of shares recently changed from £1 to 4s.

SPECIAL CORRESPONDENCE

JOHANNESBURG.

CROWN MINES.—With an increase in the tonnage milled, and a substantial improvement in the yield per ton, the Crown Mines during the last two months has shown a marked change for the better as compared with the preceding two months. Not only has this improvement to some extent restored a better feeling, but the property has regained the position as the largest gold producer on the Rand. Also the profit is well over £100,000 per month. Efforts are now being made to bring the tonnage milled up to 230,000 tons per month. As native labour is more plentiful, there seems at last some prospect of the tonnage being brought up to the capacity of the mills.

NEW MINING METHODS.—It will be remembered that much was made some time ago of the fact that the Geduld reef in the Far East Rand was comparatively horizontal, and that it was proposed to work the lode on the long-wall system. Many interesting changes have been seen at Geduld since that time, but no one seems to have mustered sufficient courage to give the system a trial. It may be pointed out that the mere fact that a lode is practically horizontal is not in itself an ample justification for the introduction of the longwall method of mining, for there are many other underground conditions necessary for successful longwall mining, several of which it may be noted do not always exist on the Rand. The most therefore that can be expected is a modification of the method to suit Rand conditions. As far as these modifications have gone up to the present, they cannot be said to be of a striking character, or such that could not have been applied with an equal prospect of success to any other method of mining.

At a recent meeting of the local Institution of Engineers, Mr. Stuart Martin read an interesting description of the Modder B mine, where more than at any other, several features which generally accompany longwall coal-mining have been introduced. For some years on the Rand it has been noticed that the cheapest worked mines were those where development operations had ceased, and taking advantage of this, Mr. Martin introduced the method of placing the development drifts far apart, thus reducing the costs of development to a minimum. In English coal-mining, it may be noted, it is as a rule found unnecessary to drive development roads in advance of the workings, on account of the regular character of the coal seams, and so the placing of the development drifts well apart was a step approaching that practised in coal-mining. Undoubtedly placing the drifts far apart materially reduced the costs of development, but in most instances has caused other disadvantages and has defeated some of the objects of mine development. In some instances it has been found necessary to reduce materially the size of the squares, before commencing stoping operations, and thus most of the saving aimed at has been lost. In others the information disclosed by the development operations has been deficient, and has led to erroneous valuations of the ore reserves, thus causing trouble and disappointment. The cutting-down of the development drifts cannot therefore in all cases be recommended, much of course depending on the underground conditions and character of the lode.

Another interesting feature described in connection with mining operations at the Modder B was the practice of systematic packing and timbering, which becomes indispensable to successful longwall mining, and one which has been far too long neglected on the Rand. With this exception, however, the resemblance to longwall mining at the Modder B was not very striking, principally because the conditions did not admit of its adoption.

Perhaps the most interesting feature of Mr. Martin's paper was the elaborate arrangement of the underground haulage, which although common to all English collieries, has not hitherto been introduced on such an extensive scale on the Rand. These arrange-

ments included endless rope, main and tail, winch-aided and self-acting inclines, as well as the old time horse-traction and hand-tramming. These methods of underground haulage on such an extensive scale are quite new to the Rand, and attracted considerable attention. Hitherto hand-tramming has been principally practised on the Rand, but now that large-scale working has become necessary, especially in the deeper mines, some better method than hand-tramming is essential. Generally speaking, this has taken the shape of electrical or locomotive traction underground, as being more suited to the underground conditions than the rope-haulage at Modder B on account of the latter requiring straight and better constructed drifts.

In the proposed application of coal-mining methods to metalliferous mining, it must not be overlooked that longwall working is far more indispensable to coal mining than to metalliferous mining, and in modifying any system of working, the underground conditions must first receive careful consideration. Then again in deep collieries, longwall mining becomes necessary to counteract the effects of the growing pressure of the superincumbent strata, and it is in this respect that in the future it may become necessary on the Rand to adopt some modification of the longwall method. Successful application of the method is not, however, dependent so much upon the question of the horizontality of the lode as upon the depth and other conditions.

TOKYO, JAPAN.

THE MINING industry in Japan, as in other countries, has suffered severely as a result of the war, most of the large companies having curtailed production since last August, and the smaller concerns abandoning all exploration. Nevertheless, the total copper production in 1914, 154,000,000 lb., was about 5% in excess of the output for the preceding year. The four leading mines produced as follows in pounds of bessemerized copper:

	lb.
Ashio	23,827,030
Hidachi	22,708,580
Kosaka	16,854,560
Besshi	16,690,040

At the Ashio the year saw numerous improvements, and working costs were reduced. Flotation, basic-lined converters, and reverberatory smelting were all introduced, while great attention was paid to organizing the 'safety first' movement. M. Otagawa, manager at Ashio, who with R. Kondo, also of the Furukawa staff, was recently given the degree of Doctor of Engineering by the Imperial University at Tokyo, has recently been on sick leave, but is recovering nicely. After the first of the year conditions in Japan showed signs of improvement, and the copper output for the leading companies rose, being for January as follows:

	lb.
Hidachi	2,165,085
Ashio	1,809,832
Kosaka	1,362,577
Shisaka (Besshi)	1,233,668

The total outputs of the leading minerals in 1914 were as below:

Gold, yen	8,953,000
Silver, ounces	4,647,767
Copper, pounds	139,676,531
Coal, tons	21,695,071
Sulphur, pounds	150,548,300
Petroleum, barrels	2,936,240

VANCOUVER.

MINING CONDITIONS.—The unfavourable effects of the European war upon the mining industry of British Columbia are not now so noticeable as they were last autumn. With markets and prices for the metals produced in the province (gold, silver, lead, copper and zinc) again normal, whatever conditions are now adverse may be attributed to other causes than the war. Of the productive mines affected by the experiences of last year, comparatively few have continued non-productive throughout the spring of the current year. Of the silver-lead mines, the most important one that had not resumed making an output of ore and concentrate by the month of May was the Standard, in Slocan mining division. The delay in again mining ore and operating the concentrating mill was, however, primarily due to the dissatisfaction of the management of the Standard Silver-Lead Co. with at least one of the conditions imposed by the smelting company to which ore had previously been sent, the particular condition objected to being an increased charge for marketing lead. However, it is expected the Standard will be again shipping silver-lead ore and concentrate before the end of May. In Ainsworth division, the Bluebell mine had not shipped any lead ore or concentrate by the middle of May. In Nelson division, the Molly Gibson silver-lead mine and the Silver King silver-copper mine have not yet resumed shipment of ore, but as both belong to the Consolidated Mining & Smelting Co., which also owns and operates the lead and copper smelting works at Trail, their continued inactivity must be attributed to some other cause. Possibly both will be at work again before these notes are published.

In the Boundary district, the mines that had been operated by the British Columbia Copper Co. have remained idle since last August chiefly for financial reasons, the company having last year up to that month operated at a considerable loss. In the Coast district, the only important previous producer not now making an output is the Britannia copper mine, in Vancouver division, but as soon as ore-handling and transportation facilities have been provided to replace those destroyed in March by a big snow slide, production will be resumed on as large a scale as practicable.

DIVIDENDS.—That the metalliferous mining industry of the province is to a considerable extent again profitable is demonstrated by the payment of dividends by several companies. The Consolidated Mining & Smelting Co. on April 1 paid a dividend for the quarter ended March 31 at the rate of 8% per annum, the amount distributed being $116,098. The Hedley Gold Mining Co. paid 5% for the quarter, amount of dividend, $60,000. The Le Roi No. 2, Ltd., on May 1 paid one shilling a share on its 120,000 shares, amount £6000. The West Kootenay Power & Light Co., which supplies the electric power to mining and smelting companies operating in West Kootenay and Boundary districts, on April 1 paid a dividend of 1¾% on its preferred shares.

REFINING.—The subject of refining metals produced in the province—copper and zinc—is being discussed. The electrolytic refining of lead is an established industry at Trail, where, too, the silver and gold contained in the lead bullion from the blast furnaces are refined. Early in April a commission visited British Columbia, consisting of Mr. David Carnegie, ordnance advisor to the Shell Commission appointed by the Federal authorities at Ottawa; Dr. Alfred W. G. Wilson, chief of the Metal Mines Division, Mines Branch of the Canada Department of Mines, Ottawa, and Dr. Alfred Stansfield, professor of metallurgy in McGill University, Montreal. In connection with the question of the suggested establishment in Canada of a copper refinery, it is noteworthy that with the exception of the mines at Rossland, which, by the way, in late years have yielded considerably less than 10% of the copper production of the province, the larger copper-producers of British Columbia are controlled in the United States. This is true of the mines of the Granby Consolidated, British Columbia Copper, New Dominion Copper, Britannia, and Tacoma Steel companies, the last-mentioned owning the Marble Bay mine on Texada island.

TORONTO.

PORCUPINE.—The annual report of the Dome Mines shows an operating profit for the year ended March 31 of $315,179, after a deduction of $173,319 for development. Subtracting $136,601 allowed for depreciation, extraordinary repairs, and improvements, there remains a balance of $178,578. The tonnage treated was 248,550, of the average assay-value of $4·25 per ton, as compared with 145,305 tons averaging $8·29 per ton during the preceding year. A reduction of working costs from $4·19 to $2·96 per ton was effected, which gives a good margin for profit on ore of last year's average. Ore reserves as on April 1 are estimated at 2,782,811 tons averaging $4·15 per ton. This estimate does not include the latest results obtained by diamond drilling below the fifth level, which indicate the occurrence of large orebodies at depth. The new issue of 50,000 shares to be offered to shareholders at par is officially announced. Each shareholder will be permitted to subscribe to one-seventh the amount of present holdings. The statement that the funds to be raised will be devoted to extensive development has induced the expectation that the present surplus may be distributed in dividends. The statement of operations in April shows a gold production of $94,863 from the treatment of 23,630 tons of ore.

The regular 4-weekly statement of the Hollinger shows gross profits of $141,457 from 22,952 tons of ore of the average value of $10·40 per ton. Working costs were $3·71 per ton, which is the lowest figure so far reported. The mill also treated 4231 tons for the Acme. The new central shaft has reached the 425-ft. level, where the first station is being cut. A new electric hoist has been installed at the main shaft, by which a large tonnage can be raised from the 1500 ft. level. The annual report of the Vipond shows a deficit of $33,365 for the year ended March 31, but for the first quarter of 1915 there was a favourable balance in the profit and loss account of $26,605, indicating that the position of the mine is improving.

COBALT.—The production of silver continues to show a decrease. Returns made to the Ontario Bureau of Mines for the three months ended March 31 give the value of silver produced as $2,488,909, being a decrease of $1,060,647 as compared with the corresponding period of 1914. The principal causes assigned are the low price of silver and the shortage of power early in the season,

though the exhaustion of some formerly productive properties is also a factor. The Nipissing during April mined ore of an estimated net value of $170,577 and shipped bullion of an estimated net value of $380,921. Shipments of bullion are again going forward freely to London.

SUDBURY. — The unprecedented demand for nickel for the manufacture of munitions of war has resulted in great activity in the nickel mining industry. The Canadian Copper Co. is largely increasing the output of the Creighton mine. A new inclined 5-compartment shaft is being constructed, and a complete new hoisting and crushing equipment will be installed. The reverberatory furnace department, which had been closed since August, has been again put into operation to treat fine ore and dust and will smelt about 15,000 tons per month. A new 25-ft. blast-furnace, larger than any in the district, is under construction, and is expected to be in operation in the autumn.

NEW YORK.

COPPER.—A few days since one of the financial periodicals of London (the *Statist*, if my memory serves correctly) complained that so little was known in England concerning the leading American copper mines, some of which so greatly outclass the Rio Tinto in point of production. The same criticism might have been levelled at the American public not long ago, but at the moment the 'man in the street' is prepared to discuss copper share issues and comparative merits with a surprising degree of fluency. The difference between Lake and electrolytic and why the former brings a premium of three to four cents per pound have become matters of common knowledge. The metal markets in copper and spelter have been so sensational that the public has become genuinely interested in possibilities and has been getting posted on orebodies, metal content, extraction percentages, and other details that help in appraising the value of market offerings. The most complacent lot of men are the producers. One, who handles as much copper as any man in the selling end, was asked the other day for some details as to the outlook. The reply was aggressive and confident. "We are sold ahead as far as we dare. It is true that the British consular representatives here visé all bills of lading on out-bound copper, but we are having no trouble. Production is rapidly getting back to normal figures, all our refinery yards are bare of copper, there is no spot metal to be had, and so far as the producer is concerned there is not a cloud in the sky. As to the further look ahead, the world needs more and more copper every year; our own mills are working overtime just now on manufactures that go abroad in the form of munitions. If our ordinary domestic demand should spring up before this particular activity in war supplies ends, copper smelting would break all records. Speaking as a producer, as well as a seller of metal on the largest scale, the lack of the demand for ordinary domestic requirements is considered an element of strength rather than otherwise. The time will come when the present insistent demand for copper and brass will cease. We are not uneasy as to whether the indispensable work of reconstruction shall begin at once or not, but if it should be that, by that time, the wire-mills should come into the market for copper, it will be an ideal sequence of events. However, the producers are exceedingly confident of their position; should it become necessary to curtail output, they will do so, as soon as they can catch their breath and the big units be slowed down. It may be taken for certain, that, in the future, when the time comes that the operator has to carry his copper, he will carry it in the ground so far as is possible. In the meantime, we feel exceedingly confident as to the outlook. The metal is one of the primary necessities of civilization, and its destruction in the conduct of the war is without any precedent. It is immaterial, in a sense, to the producer whether the work of replacement begins at once or is delayed. Our attitude is shown by the millions now being poured into new properties in development and equipment, and the millions being spent on older properties to get out more and chèaper copper. We cannot see anything in the future in copper but a producers' market, and that means that prices will be maintained. It is the belief of the producers that all of the expenditures now being made will be justified by the prosperity of the industry during the next five or ten years without regard to war profits."

The interview seemed to cover the general situation in a broad way quite completely. The new production on its way to market represents the first returns on an outlay of millions. Inspiration, Chile Copper, New Cornelia, added output from the Anaconda, the Braden, and others all mean that the world needs copper and it takes money to supply it. [We refer to the copper position in an editorial this month.—EDITOR.]

DIAMOND FIELDS OF GERMAN SOUTH-WEST AFRICA

Set in a rainless and barren desert but in sight of the sea is a diamond field that is considered capable of yielding 1,000,000 carats annually for 8 to 12 years. Its exploitation has involved many ingenious methods to overcome the exceptional difficulties. These, as seen in July last, are described.

By CHARLES W. BOISE.

INTRODUCTORY.—It is safe to say that the discovery of the diamond fields of German South-West Africa ranks among the most important that have been made since the beginning of the present century. During the six years of their history, to the end of 1913, the production has been 4,500,000 carats, valued at over £7,000,000, while during 1913 the production was worth nearly £3,000,000. This represents about 20% in value of the diamond production of the world in 1913.

The area of German South-West Africa is about equally divided by the Tropic of Capricorn, and measures about 320,000 square miles. The population is variously estimated at from 80,000 to 175,000, of which, in 1912, the German government report showed that 14,816 were Europeans. The colony has two ports, Swakopmund and Lüderitz bay, both of which are connected with the interior by railways. Walfish bay, which is the only natural harbour on the coast, as well as the logical port of entry for the colony, was retained by the Union of South Africa. In 1914 it was virtually deserted, serving only as a refuge for a small whaling and fishing fleet. Swakopmund is an open roadstead where a landing can only be effected during calm weather, notwithstanding the continued and very costly efforts which have been made by the German government to build a jetty and dock. At the port of Lüderitz there is a fairly well protected bay opening to the north. Even here, however, the landing must be made in small boats. Swakopmund and Lüderitz bay are regular ports of call for boats of the Deutsch-Ost-Afrika and Woermann lines. The voyage may be made direct from Hamburg or Antwerp, or from Southampton to Cape Town by the Union-Castle mail-boats and from thence up the coast by one of the German lines. There is cable connection with Europe at both ports. The railways under government control measured 2122 kilometres in 1912, and there were in addition 79 kilometres of privately owned lines. The standard gauge is what is known as the Cape gauge, 1·067 metres, that is to say 3 ft. 6 in., and of the government lines 1241 kilometres are of this. The remainder of the government lines, as well as all of the privately owned lines, are of 60-centimetre gauge.

The eastern part of the colony consists of a plateau having a general elevation of from 1000 to 1400 metres. The climate of this part is semi-arid. The annual rainfall averages about 30 centimetres. The crops require irrigation, though the country is well fitted for cattle-raising. Westward from this interior plateau is the main north-south watershed, reaching elevations of over 2000 metres, from which the descent to the littoral is over a series of terraces. The coastal plain, with a width from the ocean varying from 25 to 100 kilo-

metres, is a desert devoid of vegetation, and contains extensive belts of shifting sand-dunes. The rainfall over this area ranges from 1 to 5 centimetres. In Lüderitz bay, the headquarters of the diamond fields, the rainfall in two consecutive years, 1909 and 1910, was respectively 1·07 in. and 2·52 centimetres.

The diamonds occur in a detrital material, occupying a narrow zone or belt along the sea-coast, extending, intermittently over most of the distance, from latitude 24° S. to latitude 28° S., a distance roughly of 450 kilometres. Owing to the extensive prospecting that has been done during the six years since the discovery, it is unlikely that any important extension will be made by future exploration. Over the entire length of the fields the extent inland is never more than 20 kilometres; in fact a large part of the deposits are within sound of the surf, while a number are within sight of the sea itself, and a few border directly on the present beach. North of Lüderitz bay, which is the port and headquarters of the fields and is in latitude 26° 40′S., the deposits, though of considerable extent, have so far not been found worthy of exploitation. The productive part of the fields, to which my visit made in July 1914 was confined, and to which the following discussion has particular reference, commences almost due east of Lüderitz bay, a distance of some 5 kilometres, and continues in an almost unbroken belt south to Bogenfels and Frohe Hoffnung, a distance of not less than 120 kilometres.

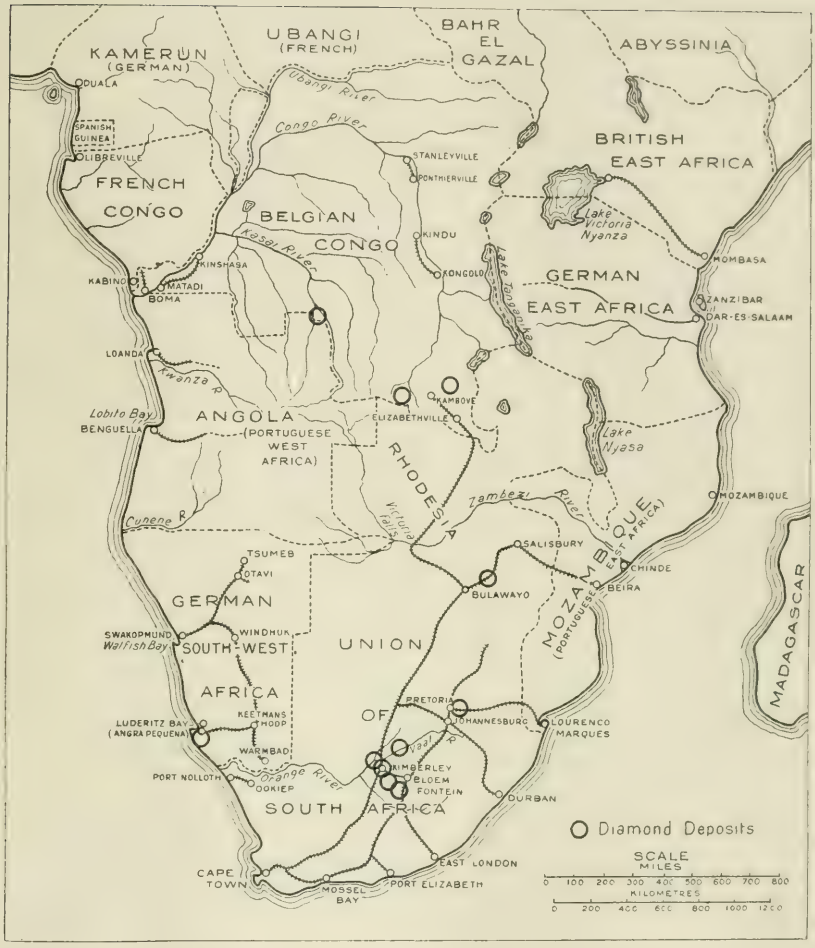
Topography.—The coastal zone is throughout of low relief. Viewed from the steamer, the low coast, alternately rock-bound or bordered by stretches of desert sand, presents a most inhospitable appearance. The desert hues are unrelieved by a single touch of verdure, and the only relief from the desolation is in a few isolated mountainous elevations rising at some distance inland. Viewed at closer range it is seen that in the vicinity of Lüderitz bay the country is composed of low, naked hills and ridges of rock, devoid of soil or vegetation, which trend in a general north-south direction and are separated by broad, shallow, basin-like valleys usually partly filled with a coarse desert sand. To the east in the background is a great belt of sand-dunes which extends in an unbroken line from an indentation in the coast a few miles south of Lüderitz bay, called Elizabeth bay, northward up the coast to Swakopmund. South of Elizabeth bay the country is rougher, the north-south valleys being narrower and bordered by more abrupt hills; a condition that continues until near Bogenfels, where the diamond fields approach the ocean, and the valleys again broaden.

The annual rainfall in this zone is very small, being from 1 to 5 cm., though at night there is frequently a heavy dew. Fresh water is not to be found, and it is rarely that any water appears at the surface. Rivers that flow toward this part of the coast disappear on entering the desert coastal region, and, while water is frequently found by sinking pits at favourable points in the valleys, such a supply is usually limited and so brackish that it is unfit for human consumption.

The principal factor in erosion and transportation is the south trade-wind, which blows constantly throughout the year, and with especial violence during the summer months. Indeed, when viewing the country from a few miles out at sea, a straw-coloured haze is noted which, through subsequent and most unpleasant experience, is discovered to consist of clouds of the finer particles of sand carried by the wind in such quantities that their impact on the face and hands may be distinctly felt. Exposed rock-surfaces are subjected to intense scouring by this constant stream of sharp sand, and frequently develop furrows trending in the direction of the wind. In rocks that are veined or banded and of varying hardness throughout, this weathering results in fantastic shapes, which form attractive specimens of desert erosion. The transporting power of this wind has an especial relation to the diamond fields, where it is constantly removing the finer portions of the sand and adding to the sand-dunes lying to the north.

Nature of the Deposits.—The diamonds occur in the superficial layer or bed of sand or fine gravel filling the bottoms of some of the valleys and of minor depressions in the bedrock. This sand is coarse and gritty, and two-thirds to four-fifths will pass a screen with 1 mm. openings. It is composed largely of quartz grains, with some fragments from the country rock, usually granite or gneiss, as well as varying amounts of chalcedonic quartz, jasper, and heavy minerals such as agate, magnetite, or garnet. Of these, significance is given to agates as indicators of relative diamond content, for it is generally accepted that not only does the diamond content vary with the percentage of agates, but that there also seems to be some relation in size.

The first discovery was made on the line of the railway by which Lüderitz bay is connected with the interior, and near the station



SOUTHERN AFRICA SHOWING THE PRINCIPAL DIAMOND DEPOSITS.

of Kolmanskuppe, which is about 7 miles east of the port. At this point the railway traverses a broad north-south valley filled with sand. Although the diamonds are contained in this superficial deposit and are of such frequent occurrence at the actual surface that they can be readily detected, not only had the railway been graded with the diamondiferous material, but the district had been crossed by several geologists, as well as by thousands of German soldiers who were employed in the interior during the native rebellion of 1904-6, without a suspicion of the nature of the shining crystals in the sand. It remained for a native of South Africa, formerly in the employ of the De Beers company at Kimberley, to make the discovery in April, 1908, as related by P. A. Wagner in his interesting account of the field.

The diamond-bearing sand usually consists only of a thin surface layer covering the bottoms of the valleys and minor depressions in the bedrock, and probably the average depth of the exploitable deposits does not exceed 0·15 metres, or say 6 in. Certain areas, however, notably on the Stauch claims as well as on the adjoining block owned by the Fiskus, have a depth of as much as 8 metres, while on one of the former claims depths of 10 metres are reported. The diamonds are irregularly distributed throughout the sand, but are usually especially prominent at the surface, owing to the action of the wind, which is constantly carrying the finer material away and thus forming a concentration of the larger and heavier particles, among which are the diamonds, at the surface. This action has resulted in remarkably rich pockets or

deposits of limited size so situated that the wind has been able to carry away all the finer material and leaving behind a concentrate of the larger materials rich in diamonds.

The general diamond content varies between wide limits. It is, moreover, usually expressed in carats per cubic metre of so-called 'gravel,' which is a product resulting from the elimination from the crude sand of the fine material under ½ mm., and of the coarse material over 6 to 10 mm. Even within limited areas the yield is not consistent, owing to the fact that the diamonds seem to follow irregularly defined streaks or runs. In the famous Ida Tal deposit of the Pomona company, the wind concentration has proceeded to such an extent that there is only a thin spread of comparatively coarse material over the rock-floor of the valley, and this deposit over considerable areas has yielded, according to report, about 60 carats of diamonds per cubic metre of 'gravel' washed. The percentage of the crude material in the field which this product represents is not stated, but it may be estimated at a third, which brings the diamond content of the original material to about 20 carats per cubic metre. Such high content, however, is exceptional. Farther to the north, where the most extensive deposits are found, screened gravel running 1 to 1½ carats per cubic metre is an average, and one of the northernmost of the principal companies is regularly treating material from which the screened product for the plants carries only ½ to ¾ carat per cubic metre. Assuming that this gravel represents only a fifth part of the crude sand, a fair estimate for this part of the field, the original material carried only one-seventh of a carat per cubic metre. An estimate that the principal fields in the areas at present under exploitation, with the exception of Pomona, carry from a half to a tenth of a carat per cubic metre of crude material will not be far in error.

Quality of the Diamonds.—An inspection of lots of diamonds shows at once their general white colour, excellent quality, and uniform size. Cleavage fragments are comparatively rare and bort almost entirely absent. Wagner estimates that fully 85% of the stones are fit for cutting, and states that while "many of the crystals show unmistakable signs of wear, typically waterworn stones such as are so common on the Vaal River diggings do not appear to occur." The stones found are remarkable for their uniformity of size, but there is a fairly regular variation in average size of the diamonds recovered from various parts of the field, with a noticeable increase in size from north to south. The total production at present averages almost exactly 6 stones to the carat. The largest stone found weighs 34 $\frac{13}{64}$ carats.

Source of the Diamonds. — It is at present conceded by nearly all of the geologists who have made a careful study of the fields that the immediate source of the diamonds, or at least one of the sources, is in marine terraces, remnants of which are still to be seen, particularly near Elizabeth bay and Bogenfels. These terraces have presumably at one time filled the present depressions in the basement of the country, and their breaking-down through weathering, probably largely desert erosion, has furnished a large part of the materials making up the present surface detrital deposits and exposed the topographic features of the present day. The terraces are believed to belong to either the Upper Cretaceous or the Tertiary, or both, and have been proved to contain diamonds, as well as the agates and chalcedony associated with the diamonds in the more recent deposits.

Recent investigations have reduced the numerous theories formerly held regarding the original source of the diamonds to the two that follow, each of which has its ardent supporters:

(*1*). The diamonds have been released by weathering from rocks exposed in the district, that is, the crystalline rocks forming the basement system, or from more recent intrusives which are found in certain parts of the fields.

(*2*). That the diamonds have been derived from an intrusion or intrusions which now lie submerged off the coast.

The theory formerly advocated by some observers that the diamonds had been brought down to the sea by the Orange river and that they were derived from the South African deposits was proved unsupportable by the fact that the diamonds do not in the least resemble those produced in South Africa, as well as from the fact that the present gravel in the Orange river near the coast is barren of diamonds. Likewise the idea that they came from the interior of the German colony, where there are occurrences of an intrusive similar to kimberlite, was given up when these intrusions, as well as the river courses leading to the coast, gave negative results. A further feature bearing on both of these theories is the absence of typically river-worn stones, such as are seen in the Vaal River diggings.

Of the two theories still tenable, those who support the idea of a submerged source off the coast draw attention to the fact that at some places along the shore material at present being washed up by the sea is diamondiferous, to which evidence is added the occurrence of diamond-bearing detrital material on the adjacent Guano islands just off the coast. The supposititious source is off the coast from the Pomona area, in which the richest deposits occur, and where the diamonds reach a maximum average size. It is interesting to note that, following out this idea, a company was formed to dredge the sea-floor off the Pomona coast, but their efforts were arrested by the issuing of an Imperial decree investing all rights in such deposits in the Colonial Government.

Regarding the theory of an original source within the fields, it can only be remarked that, while so far as reported all efforts to trace the diamonds to igneous rocks in the district have yielded negative results, much research remains to be done before the evidence can be considered as conclusive. Thus sufficiently decisive evidence is not yet at hand on which to adopt either theory to the exclusion of the other.

EXPLOITATION.—The exploitation of the deposits has been in the hands of six principal companies. While a number of smaller companies are operating, their production is insignificant. The work is carried out under strict government control, and the industry is taxed heavily. The production is sold through a government agency in Berlin, called the Diamant Regie. This organization also limits the amount of diamonds that may be sold during the year by any particular company, the total amount depending on a forecast for the year of the diamond market, the distribution of this amount among the various companies being made on the basis of the size and importance of their properties and their producing capacity. In the following list will be found the names of the six principal companies, and the 1914 limit of production for each company which will be sold for the year:

Name.	Limit. Carats.
Pomona Diamanten Gesellschaft	350,000
Kolonial Bergbau Gesellschaft	257,500
Deutsche Diamanten Gesellschaft	125,000
Diamanten Pacht Gesellschaft	103,500
Kolmanskop Diamond Mines, Ltd.	89,500
Vereinigte Diamant-Minen Aktien-Gesellschaft	55,000

PROSPECTING METHODS.—Prospecting operations are comparatively simple. Not only is the diamond-bearing material a surface deposit, but it is generally loose and unconsolidated, of comparatively shallow depth, and the concentration due to the action of the wind is at the actual surface, so that frequently a careful inspection of the surface will indicate whether or not the field will be worthy of exploitation.

PART OF THE DIAMOND FIELDS, SHOWING THE PROPERTIES OF THE SIX GREAT COMPANIES.

The simplest method of prospecting consists in starting a crew of 'boys' familiar with the appearance of rough diamonds over a certain part of the area. From the amount of diamonds collected by the crew, who crawl over the area on all fours, together with the time occupied and the area covered, an estimate is made as to whether or not the field will pay for exploitation. This

simple method, which is of especial use in shallow deposits, is usually supplemented by more detailed work, either by means of trenches across the deposit or by pit-sinking, if the deposit is of some depth. In the trench work, the trenches are always laid out at right angles to the direction of the prevailing wind so as to cut across any streaks or zones of relatively high concentration. In very shallow ground the trenches may be a metre and a half in width, while in deeper ground the width is usually one metre. The whole material from the trenches is usually tested. The practice in division of the samples varies. Sometimes the samples represent five-metre sections of the trench. In the practice of another company the length of the section varies with the depth of the ground, the crude material being that amount which will yield for the test, after the removal of the oversize and the undersize, a quantity of one cubic metre. The trenches are spaced at intervals of from 50 to 200 metres, and are sometimes a kilometre or two in length.

While the trench-prospecting is in general use, it has been found unsatisfactory for the deeper ground, say over a metre or a metre and a half in depth. In such ground the practice is to sink pits about two metres in diameter through the deposit, the spacing being such that there are three to five to a hectare. The entire sample from each pit is tested. In the deepest ground, however, pit-sinking is not very practical, and it is understood that one company in whose property lie some of the deepest deposits of the fields, has ordered for their testing a rotating drill of 30 cm. diameter following closely in design hand prospecting drills of the type now on the market.

In the treatment of the samples for the recovery of the diamonds, various methods are in use. The crude material, which according to local practice is called 'sand,' is measured and then screened dry to remove the undersize (that below 1 to 2 mm., depending on the practice) and the oversize (about 6 to 10 mm.). The intermediate product, which is called 'gravel,' is then washed for diamonds. This may sometimes be done by hand gravitating in circular screens operated in a tub of water. The more usual method is to concentrate the gravel in small hand-power movable-sieve jigs. In the case of shaft samples, it is the practice of one company to wash them in one of its mechanically operated plants.

It is interesting to note the accuracy of the prospecting results over areas which have subsequently been exploited. The margin of error seems to be appreciable, and it is understood that some markedly erroneous estimates were made at the beginning of the work. Further experience with the testing methods, and above all the great improvement in the concentration methods since the general introduction of power plants, have reduced this margin. It is especially interesting to note that, from the experience of two of the large companies who have carried on extensive prospecting and exploitation for a number of years, the estimates of the diamond content of a field when based on results derived from samples which are washed either by hand or in hand-power jigs are uniformly low, the actual recovery being from 20 to 30% above the estimate. With shaft prospecting, where the samples are treated in the power-plant, this margin disappears.

The cost of prospecting according to the above described methods is comparatively moderate, if one considers the relatively high cost of labour, the remoteness of the country, and especially the difficulties and expenses in securing water for the washing operations. The records of one of the large companies owning about 4000 hectares of ground show that the cost of prospecting the part of this area containing sand deposits, inclusive of technical work, mapping, etc., has been about £10,000. The exact area prospected is not stated, but from the fact that between 1000 and 1500 hectares of the area has been found exploitable, it may be estimated that the area actually prospected will be at least 2000 hectares. Taking the minimum figure given for the exploitable area, the prospecting has cost only £10 per hectare.

MINING.—The excavation of the material, which usually presents no difficulties with ordinary picks and shovels, is carried on almost entirely by hand. The only exception to this at present is in the case of the Kolmanskop Diamond Mines, Limited, where in one of its mines containing deep sand an electrically-driven sand-dredge is employed. The Koloniale Bergbau Gesellschaft, and the Diamanten Pacht Gesellschaft, which are building huge concentrating plants near Kolmanskuppe, will, on the completion of their plants, employ mechanical excavation by means of electric shovels.

After excavation, the crude sand is screened on the spot. This operation is carried on without water and is done entirely by hand at present, except in the single case of the sand-dredge, to which reference is made above,

where power-screening is employed. The hand-screening is accomplished either by means of trommels or by swinging screens, which are the 'babies' of South African practice. By this operation a product is obtained called gravel, which ranges in size, depending on the part of the field, from 1 to 2 mm. up to from 6 to 10 mm. This gravel represents from a fourth to a sixth of the volume of the crude sand, an average for the whole field being probably between one-fourth and one-fifth.

Owing to the deposits being thin and widespread in general, it is frequently necessary to transport the screened gravel a considerable distance to a central treatment plant. This is accomplished by means of 60-centimetre tracks and $\frac{3}{4}$ cubic metre side-tipping cars. The track is usually laid down the centre of the deposit under exploitation. The distance for tramming ranges up to 5 kilometres, in the case of one large thin deposit where the washing plant is of such a size that its removal would be a matter of considerable expense. The tramming is sometimes done by hand where the distance is short, but the usual practice is to use a team of small mules drawing a train of a number of cars.

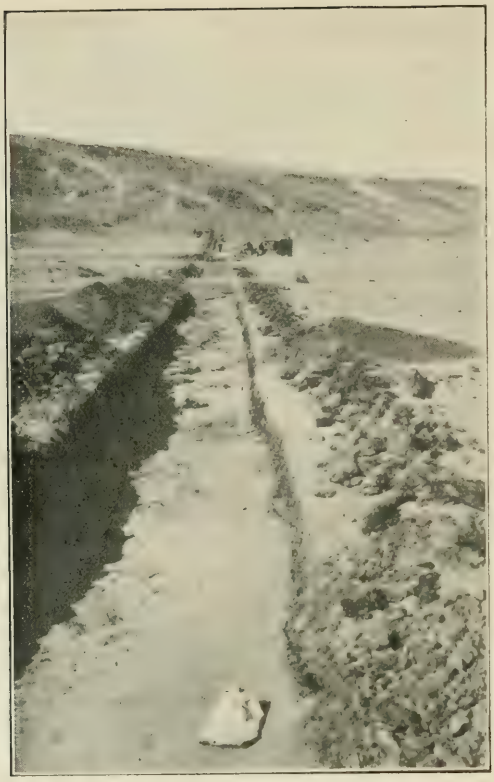
The concentrating operation is at present carried on almost exclusively in central plants equipped with power-driven concentrating machines. The hand-concentration or hand-gravitating has entirely disappeared from the practice of the large companies. The same is nearly, though not entirely, true of the hand-power movable-sieve jigs, though the latter are in general use for prospecting. The central washing plants in operation at present are all of the same general pattern, and range in capacity from 1 to 4 cubic metres of screened gravel per hour. The operation includes dry-sizing in trommels to divide the gravel into two sizes, and a wet-concentration in a clever jigging machine called the Schiechel pulsator separator, which operates somewhat on the principle of the Richards pulsator jig. At present it is estimated that there are over 200 of these separators in the various plants in the fields. A variation from the present practice in concentration will be had on completion of the two large Kolmanskuppe plants, where the flow-sheet shows a combination of separators with the ordinary piston-plunger jig of the Hartz type, the latter being given particular emphasis in the treatment of the larger sizes.

The sorting of the concentrates produced by the various plants for the diamonds is done entirely by hand. In the case of the large companies the concentrate, after passing several sortings, is passed through a magnetic separator where the volume is reduced greatly by the removal of the magnetic materials before the final sorting.

Excavation and Screening.—The excavation and preliminary screening are carried on simultaneously in present practice. This will not be true in the two large Kolmanskuppe plants. The excavation is simple, though it may be well to note the care which is always taken to clean the bedrock, which is usually somewhat hummocky. This is of especial importance in the thinly spread deposits where the uneven rock-floor forms pockets and riffles, which it has been found catch the diamonds as effectively as they might gold. A favourite method of removing the last of the deposit is by the use of brushes with long bristles, and fastened to long handles. With this instrument it is possible to sweep the bedrock, including the ordinary depressions, practically clean.

While in general the diamond-bearing sand is readily excavated, there are, in some cases, especially where the deposit has some depth, occasional cemented layers. In the past little attention has been paid to this material, though it has been recognized that it carried usually the same content in diamonds as other parts of the deposit. More recent practice is providing for the treatment of this material, and in some cases this cemented part of the deposit is being excavated and stored pending the completion of the plant for its reduction. In some parts of the field this cementing is not so tight that it cannot be broken down with a pick. At other times the use of dynamite is necessary.

For the hand field-screening there are two machines in use. The one which seems to be given the preference on a basis of greater efficiency is a light trommel about 3 metres long by 80 cm. in diameter, and mounted on a light wooden frame. These trommels are of the hexagonal pattern, and are covered by light brass-wire screens having openings of from 1 to 2 mm. The oversize is removed at the head of the trommel into which a cone-shaped screen, having openings of from 6 to 10 mm., is fitted. The crude material as it is excavated is thrown by shovel into the head of the trommel, where it is received by the cone-shaped coarse screen, the oversize discharging from the head of the trommel. The smaller sizes pass through into the main trom-



PROSPECTING TRENCH ACROSS A SAND-FILLED VALLEY NEAR POMONA. NOTE THAT THE SAND IS BEING TESTED IN A PORTABLE HAND-POWER WASHING MACHINE AND THE HILLS OF NAKED ROCK IN THE BACKGROUND.

mel, the undersize continuing through and falling beneath the screen, while the so-called gravel discharges from the lower end.

In the second method of hand-screening, the swinging screen known as a 'baby,' but here called a *schüttelsib*, is used. As employed in German South-West Africa, a coarse screen for the removal of the oversize covers about the upper third of the main screen. In some cases this coarse screen is given a reverse pitch to that of the under screen, so that the oversize discharges at the head of the machine. In other cases both screens have the same pitch, the oversize being made to discharge at one side, through the board forming the lower side of the coarse screen frame being given a rake in that direction.

The principal difficulty which is encountered in this hand-screening is through the frequent presence of sufficient moisture in the sand, due to the heavy dews, to clog the fine screen. This at times makes the work very laborious and greatly reduces the output of the screens. The amount of screened gravel produced by one of these screens per day depends also on the relative proportions in the original material of the various sizes. In crude sand, which runs high in undersize, operations are much slower than in ground which runs higher in the coarse sizes. In most parts of the fields it will require a battery of from 15 to 25 screens of either type to furnish 90 to 100 cubic metres of screened material for the plants. The labour will require, for the excavation, screening, and delivery of the gravel to the tram-line and loading it into cars, from 100 to 150 blacks. For this crew from 1 to 4 overseers will be required, depending on whether the work is scattered or not. The screens advance across the field in a line, as shown in the illustration on page 329, the tram-road to the plant usually being laid down the centre of the strip under exploitation. Cross tracks at right angles to the main line and paralleling the line of screens on either side of the central tram-line are kept a short distance ahead of the work. To these cross lines the screened material for the plants is brought, usually in boxes provided with handles which are carried by two men, but sometimes in wheelbarrows where the nature of the ground permits, and dumped into piles from which $\frac{3}{4}$ cubic metre side-tipping cars are loaded. These cross tracks are not as a rule connected with the main line by a switch, a clever style of movable turn-sheet being provided for transferring cars from one track to the other.

The Kolmanskop Diamond Mines, Limited, in one part of its fields is employing an interesting sand-dredge shown in an illustration on the cover. A study of this will furnish a general idea of the operation of the machine. The dredge is of all-steel construction, electrically driven, and combines a digging and elevating bucket-line, screening apparatus, and a system of belt-conveyors for the discharge of the oversize and undersize into the worked-out ground beyond the working face. The machine is self-propelling and runs on a track of heavy rails of 2'6 metre gauge. The bucket-line is of the link type, and the buckets are of about $\frac{1}{15}$ cubic metre capacity (or say two cubic feet). As will be noted, the bucket-line works in the reverse direction from that of a California gold dredge, the loaded buckets coming up on the underside of the ladder and dumping on top of the upper tumbler. The reason for this arrangement lies in the fact that the dredge must keep ahead of the working face, as the undisturbed sand makes a

much better foundation for the track than the uneven bedrock. The material dumps from the buckets into a chute fitted with a 5 cm. grizzly, the oversize from which consists almost entirely of cemented blocks of the deposit, and is led through a launder into mine cars and stored on a dump for future treatment. The undersize from the grizzly is divided into four equal parts, which are fed into four trommels of the hexagonal pattern. These trommels are of the jacketed type and are fitted with screens of $1\frac{1}{4}$ and 7 mm. openings, thus giving three products, of which the undersize and oversize fall on a cross conveyor-belt delivering to a main tailing-conveyor which discharges them into the worked-out ground beyond the working face. The intermediate size, $1\frac{1}{4}$ to 7 mm., runs through a chute into $\frac{3}{4}$ cubic metre cars for delivery to the treatment plant. The narrow gauge track for the mine cars is laid parallel to the dredge track, and the cars, during the time they are filling, move automatically with the dredge. The capacity of this dredge in ordinary ground is from 600 to 700 cubic metres of crude material per 12 hours. The power consumption is about 40 hp., the electric power being derived from a central power-plant in Lüderitz bay, which supplies power to a number of large companies operating in the northern part of the fields. The staff required to operate the dredge is an overseer, a white mechanic, and from 16 to 24 natives.

CONCENTRATING METHODS.—At present, leaving out of consideration the operations of some very small companies, and the two uncompleted Kolmanskuppe plants, concentrating plants are of two general types, consisting of batteries of hand-power movable-sieve jigs, or of power-driven plants employing as a concentrating machine the Schiechel separator. The hand-power plants, due to their proved inefficiency, are rapidly going out of use for any extensive operation. The mechanically driven plants introduce several interesting features, including elimination of field-screening, wet sizing, provision of crushing machinery to break the cemented portions of the feed, and the use of Hartz jigs in combination with the Schiechel separators. Electric power from the Lüderitz bay station will be used.

WATER SUPPLY.—There is no source of fresh water within the part of the diamond fields under discussion, and even the brackish water which is sometimes found by sinking in the valleys is limited in supply. This scarcity of a thing so essential has undoubtedly been one of the most serious difficulties encoun-

FIELD SCREENING IN 'BABIES' NEAR BOGENFELS. THIS DEEP DEPOSIT OCCURS IN A SMALL BAY IN THE ROCK-RIDGES FLANKING THE VALLEY, AND CONSISTS LARGELY OF DRIFT SAND MAKING THE SCREENING OPERATION VERY EXPENSIVE.

tered, and it remains today an item for careful consideration in the undertaking of new work, as well as a prominent factor in the operating costs. For water for the washing plants in the northern parts of the field, sea water pumped through the pipe-line, of which mention has already been made, is used extensively. A few isolated plants in this vicinity rely on the brackish water from wells. The cost at Kolmanskuppe of the water brought by the pipe-line is not stated, the amount depending on the quantity used, which will not reach a maximum until the two large plants which have been built are in operation. South of Elizabeth bay the plants are forced to rely principally on wells, though in those fields which are near the ocean sea water is used. At the Granitberg and Bogenfels plants of the Deutsche Diamanten Gesellschaft, wells have been sunk at the plants, which furnish a supply that, with careful husbanding, is sufficient. In some cases the water is delivered to the plant in small tank cars, operated on the tram-line. Another method where track is not available is the use of ¾ cubic metre casks, which are converted into rollers by the attachment of a tongue, and are drawn without difficulty over the sand by spans of small mules. Water-carts are also used to some extent, and in remote parts of the fields camels loaded with small tanks are occasionally employed.

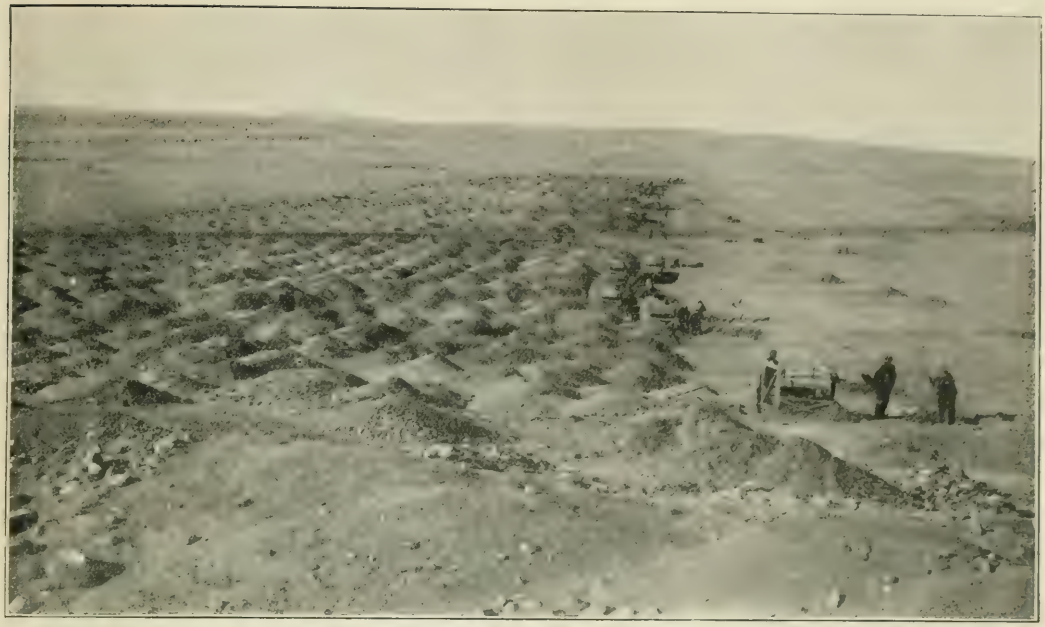
Fresh water for domestic use was originally brought in tanks by steamer from Cape Town, a 36-hour voyage to the south. The present supply comes partly from the interior by the railroad, a distance of over 100 kilometres, and the remainder is evaporated from sea water. In Lüderitz bay, fresh water from either source costs at present 14s. per thousand litres (or 1 metric ton). In the field the cost is usually more owing to the additional charge for transport. At remote points the usual method is to erect small evaporating plants at the coast. Under such conditions the cost per 1000 litres may easily be as much as £3.

LABOUR.—At the time of my visit (July, 1914) there were employed in the diamond fields a total of nearly 5000 natives, while of Europeans there were between 400 and 500. All of the manual work is done by natives, who for the most part come from the northern part of the colony and are called Ovambos. The remainder of the workmen are Cape natives. Of the workmen the latter are the most expensive class of labour and are paid from 2s. to 2s. 6d. per day, in addition to which one must calculate the cost of food and housing, as well as the recruiting expenses and the cost of the voyage. The actual cost of the Cape labour is from 4s. 6d. to 5s. 6d. per day. The Ovambos are paid at the rate of 25s. per month plus food, lodging, etc., and are the more popular labour of the two on account of the lower wage, but unfortunately the supply of this class of workmen is limited. Overseers, mechanics, and even carpenters are usually Europeans. Unskilled or semi-skilled European labour wage is from 8s. to 15s. per day, plus board and lodging, an additional amount of from 3s. 6d. to 6s. per day, depending on location.

TRANSPORT.—The problem of the transport of supplies, machinery, etc., which must have been a serious problem in the early days, has been well solved by the use of the 60-centimetre gauge railroad. A line of this dimension leaves the government line from Lüderitz bay to the interior at Kolmanskuppe and continues south through the centre of the fields to Bogenfels. Numerous spurs connect this line with adjoining fields, as well as with the ocean at Prince bay, south of Elizabeth bay, where freight for the southern part of the fields has always been landed. This line serves not only as a method of freight transport, but it is also frequently made use of for the transport of screened gravel from the field to washing plants. It is unique among railroads in that for a considerable part of its length it is graded with diamondiferous material.

POWER.—The power used is of two types, electric power, furnished by the power-plant in Lüderitz bay, of which mention has already been made, and that from internal-combustion motors. The Lüderitz bay power-plant employs motors using producer gas and furnishes a three-phase current at a pressure of 30,000 volts. The transmission line runs from Lüderitz bay east to the fields near Kolmanskuppe, and then south paralleling the 60-centimetre railroad to Elizabeth bay, where current is supplied to the pumping-plant for the sea-water pipe-line. The majority of the washing plants in the vicinity of Kolmanskuppe use this power. The ordinary cost is 4d. per kilowatt-hour, but it is understood that special contracts showing a considerable reduction are made with large users.

All of the mechanically operated plants south of Elizabeth bay, and some of those north of that point in the vicinity of Kolmanskuppe, use as motive power internal-combustion motors. These engines range



FIELD SCREENING WITH 'BABIES' NEAR BOGENFELS. THE WORKED OUT AREA IS TO THE LEFT. AT THE RIGHT MAY BE SEEN HEAPS OF SCREENED 'GRAVEL' READY TO BE LOADED IN TRUCKS AND SENT BY THE 60 CM. RAILWAY WHICH TRAVERSES THE FIELD, TO THE CENTRAL WASHING PLANT.

from 6 to 25 hp., and the fuel used is either benzol or American kerosene. In the vicinity of Lüderitz bay, where transport charges are not so heavy, an advantage in point of economy is claimed for the kerosene, while at fields more distant benzol is given the preference. The consumption of benzol in motors of medium size is from 0·20 to 0·25 litres per horse-power-hour, while with kerosene this figure is increased to from 0·32 to 0·36 litres. According to the figures of one company operating near Kolmanskuppe, which employs kerosene in their motors, the average cost per horse-power-hour is from 3 to 3·1d., this figure including lubricating oil, repairs, and depreciation, though not superintendence. The fuel costs from 7s. 6d. to 8s. 3d. per case of from 33 to 35 litres in Lüderitz bay, while in this case transport to the field costs 6 to 10 shillings per ton.

COSTS.—The cost of exploitation per cubic metre of the crude sand or of the screened gravel varies between wide limits, depending on the position of the field, the scale of operations, cost of water supply, and also on the nature of the deposit, as to depth and relative proportions of the various sizes. Costs per unit of volume are probably a minimum in the vicinity of Kolmanskuppe, where freight charges are relatively low, the deposits have a fair average depth, and the scale of operations is large. Costs exclusive of administration, depreciation, etc., here run from 6s. 6d. to 10s. per cubic metre of screened gravel passing through the plants, which means that this cost for the crude sand was from $1\frac{1}{2}$ to 2 shillings per cubic metre. These figures may usually be divided on the basis of 60% for excavation and screening, and 40% for the washing-plant costs. In more remote fields the costs rapidly increase. For instance, at Frohe Hoffnung, the southernmost point at which extensive operations have been carried on, operations are so expensive that material from which the screened gravel carries 2 carats per cubic metre cannot be profitably exploited. The cost of production per carat shows a wider range than the cost per cubic metre of sand or gravel, owing to the wide variation in the yield in different parts of the field. In the richest field, Pomona, the cost is approximately 2s. per carat, while in the case of some of the more isolated fields the cost per carat may readily reach 35s. At and near Kolmanskuppe in the northern part of the fields the cost ranges from 7s. to nearly 20s. per carat. The Kolmanskop Diamond Mines, Limited, in 1913 produced diamonds from

screened gravel running 0·98 carats per cubic metre (or a fifth of a carat per cubic metre of crude sand) at a working cost per carat of a trifle over 9s. A calculation of average working cost per carat for the six principal companies, made on the basis of the 1913 reports, and with the respective productions in the proportion as limited for the government for 1914, gives 7s. 2d. The average value of the diamonds, on the same basis and at the average market price for 1913, would be 40s. 9d., thus making the working cost, which includes neither head office expenses, marketing commissions, nor the direct tax against the industry, only 17·7% of the value. It is interesting to note that, on the basis of the government tax in force during the first part of 1914, between 60 and 65% of this apparent profit would be taken by the government. Removing from the calculation for average working cost per carat the Pomona production, the cost becomes 10s. 4d. per carat, which would be worth 33s. 3d., thus making the working cost 30·7% of the value per carat.

Government Regulations and Taxation.—It has already been stated that the diamond-mining industry in German South-West Africa is carried on under strict government regulation and that the profits from operations are heavily taxed. The government exercises a monopoly of the trade in diamonds from the colony, the producers being compelled to turn their production over to a government organization called the Diamant Regie, with headquarters in Berlin, which undertakes the sale of the diamonds. In addition to this the same organization sets a limit each year, depending on a forecast of the diamond market, on the diamonds which they will put on the market. This limit is distributed among the different companies working in the field according to their producing capacity. Government taxation of the industry is in the nature of a profit tax. This amounts to 66% of the total value of the diamonds sold, less 70% of the cost of production, which may not include capital expenditure, though 10% annually on this expense may be written off for depreciation. In addition 2% of the gross value goes to the Regie as a selling commission. This system of taxation seems to be admirable in many ways, and is much preferable to a production tax which was formerly collected.

In order to collect a tax of this nature it is evident that the Government must maintain close supervision of the field operations. This is accomplished by means of a special squad of police. Daily log-books must be kept at each of the working places, in which certain information required by the Government must be recorded, and the police from time to time inspect these books and verify them. A copy of this daily log-book must be handed to the local agency of the Regie with each lot of diamonds.

In addition to the police squad there is a special force of government detectives whose chief duty it is to prevent theft. This danger is fortunately much more easily avoided than in South Africa, for in the diamond fields under discussion, set as they are in a rainless and barren desert, the only habitable spots are those provided by the mining companies. There are no other inhabitants of the district, and absolutely no unattached transients. Of the native workmen, the Ovambos, at the completion of their term, return to their homes in the northern part of the colony, where they would find little opportunity for the disposal of stolen goods, while the Cape natives could find a fairly ready market at Cape Town. For this reason Ovambos are employed almost exclusively on the sorting. All natives on leaving the port of Lüderitz bay must pass through the detective bureau and are liable to being searched. Supervision of the Europeans is less strict, and it is likely that the greatest loss from theft is through this channel.

Future of the Fields.—A definite forecast of the future of the German South-West Africa diamond fields is difficult to make. For, while the area containing deposits which are exploitable, or likely to become exploitable, has been fairly definitely outlined through extensive general prospecting, only a limited amount of thorough development has been accomplished in any part. Moreover, development results are not as a rule available. Assuming that the conditions in the diamond market will continue as they have been during the first part of 1914, and using as a basis statements made by competent persons in the fields, available data in publications and company reports, and personal observations, a conservative estimate shows that the diamond fields of German South-West Africa should be able to continue production at the rate of 1,000,000 carats per year for from 8 to 12 years, while certain of the larger deposits should continue production for a considerably longer period. One can therefore confidently predict for the fields a long and prosperous future.

THE GOLD MINES OF THE LENA.

To the end of 1914 the recorded production of the claims now under control of the Lenskoi company amounted to £40,000,000. This, one of the greatest, if not the greatest placer fields of the world, is still far from being completely prospected. The peculiar mining conditions and methods employed are described.

By C. W. PURINGTON.

MAP OF THE LENA RIVER AND BAIKAL DISTRICT, SHOWING THE SITUATION OF THE LENA GOLDFIELDS.

THE property of the Lenskoi Gold Mining Company, in which a controlling interest is held by the Lena Goldfields, Limited, of London, is situated mainly in the Vitim district of Siberia, a smaller portion being in the adjoining Olekma district.

GENERAL SITUATION. — The territory within the limits of which the property is situated lies between the parallels 58 and 59° N, and the meridians 112 and 115° E. The journey to Bodaibo, which is the south terminus of the company's 3-ft. gauge railway, is made by automobile from Irkutsk, 240 miles north to Zhigalovo, thence 700 miles down the Lena river and 200 miles up the Vitim on slow river steamers. The average journey from Irkutsk to Bodaibo takes 10 days in summer, and about 12 days to return. The first boat reaches Bodaibo on June 10, and the last leaves on September 29. In winter the route is by sledge all the way from Irkutsk to Bodaibo, the time being about the same.

The entire route from Kachug to Vitim along the Lena is marked by red sandstones with underlying limestones, which are probably of Devonian age. The beds become

gradually more folded and distorted as one proceeds north. No mountain peaks of any prominence are visible until the big balds *(Goltsi)* lying between the Vitim and the Big Patom become visible. These are evidently granite masses which have pushed their way up through the sandstones and limestones. Along the Vitim evidence of disturbance and metamorphism becomes stronger as one approaches Bodaibo. A quaquaversal uplift of gigantic proportions affected the previously buried Silurian and Cambrian rocks, and the gold veins from which the alluvial gold was derived are due to the metamorphic processes accompanying this uplift.

The climate of the district resembles that of New England, except for the three months of exceptionally cold weather in winter. Climatic conditions are healthy and enjoyable, and the scenery almost exactly resembles southern New Hampshire, U.S.A. Timber is pine, larch, and spruce of medium size.

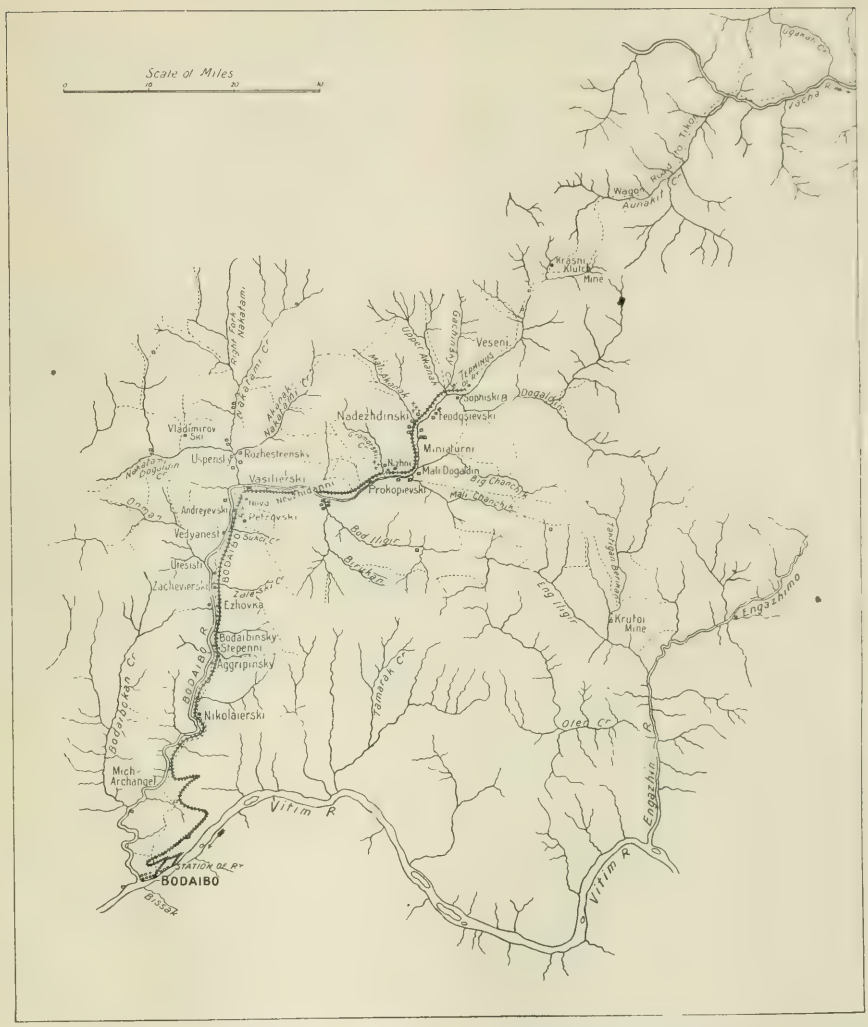
TOPOGRAPHY.—The region is topographically a series of mountain domes, rising from 3000 to 4000 ft. above the level of the Vitim and adjacent streams, which level itself is only about 700 ft. above the sea. The Kropotkin range, of an average elevation above sea of 4000 ft., forms the east and west divide between the Bodaibo and Engazhimo rivers on the south, and the Anangra, Aunakit, and Vacha creeks on the north, and is the seat of the quartz veins and auriferous rock from which the bulk of the alluvial gold is derived. This range is paralleled both to the north and south by others, having the same general trend, a little north of west, and varying in height. The greatest height of land is represented by Mount Longdor, 6916 ft., situated over 100 miles to the east of the Bodaibo.

The ranges of dome-like mountains are the remnants of a vast plateau, and the descent from the peaks to the stream levels is marked by a series of six or more well defined terraces or benches, showing that sharp alternations have occurred in the rates at which erosion has been accomplished.

Evidence is extremely well marked that extensive river systems in past geological time have occupied horizons at from a few feet to over 1500 ft. above the present stream valleys. Masses of alluvium of important width and thickness, in some of which the presence of alluvial gold has been established, occupy the non-eroded portions of these high channels. The situation of the present streams affords little guide to that of the ancient ones. While following generally the same directions, their courses exhibit parallelism rather than coincidence.

One peculiar topographic feature is remarkably accentuated in the Lenskoi region. That is the existence of extensive basins in the upper portions of the stream valleys, in which the burden of alluvium is from 100 to 250 ft. in depth, followed by cañons and narrows in the parts of the creeks adjacent to the mouths, with an alluvial cover of from 20 to 35 ft. only. The Bodaibo, Engazhimo, Anangra, Kadalikan, and Ugakan all exhibit this feature, and many instances occur on a smaller scale. How much this is due to a superimposed blanket of pseudo-glacial debris which appears especially prominent in the heads of streams, and how much to a more than usually rapid, pronounced, and widespread disturbance of the topographic equilibrium, it is extremely difficult to determine.

GEOLOGY.—Russian geographers insist for the most part on the wide prevalence of glacial phenomena in the Bodaibo and adjacent drainages. I am sceptical concerning general glaciation of the region. It seems rather that each valley or catchment basin has an annually repeated glacial period, when the packed snow and accumulating ice of the streams together succeed in forming an ice sheet of considerable dimensions. These sheets are frequently a mile or more in length, from 10 to 15 ft. in thickness, and fill the width of the valleys, from ½ to 1½ miles. They do not melt away until early September, and in some seasons last the year through. They carry large stones and boulders for distances of many hundreds of feet. Ramparts, of morainal character, consisting of the rounded river gravel, may be seen scattered over the grassy plains, at distances of 500 ft. and more away from the creek beds. On the side hills and bench slopes, layers of sub-angular debris, of sizes from 6 in. to 2 feet in diameter, often form a blanket up to 3 ft. in thickness on the surface of the peat, fine sand or gravel. It is entirely evident that this debris is merely laterally transported from the valley rims by creeping annual ice sheets. Along the creek beds themselves, especially the upper Bodaibo and Big Dogaldin, these sheets of angular debris entirely cover up the true surface of fine gravel, peat, or muck. The debris consists almost entirely of the sandstone and arenaceous shale which makes up the underlying bedrock, and true glacial erratics are rare. In fact the origin of the rounded granite boulders in the gravel is in my estimation subject to more than one explanation.



MAP SHOWING THE PRINCIPAL PROPERTIES OF THE LENSKOI COMPANY; THERE ARE ADDITIONAL CLAIMS TOWARD THE NORTHEAST, JOINING THOSE SHOWN ON THE MAP.

The country rock, as has been noted, is sedimentary in origin. Dikes of igneous rock in the sedimentary area are rare. What may be called the Bodaibo geologic basin, an area of tilted sandstones, roughly 25 miles wide by 50 miles from north to south, is probably underlain entirely by granite. This granite, generally of coarse and pegmatitic habit, appears on nearly all sides of the Bodaibo basin, and forms whole mountain masses to the south, across the Vitim river, to the east, on the left tributaries of the Engazhimo, and to the north, on the lower Anangra. Farther to the north other sedimentary basins appear also associated with granite masses and laccoliths, and wherever found gold occurs in the streams. The areas are also marked by the occurrence of mica schists of probably Cambrian age, the latter areas being much poorer in gold occurrence. These are frequently garnetiferous and of silicious habit.

The ranges are penetrated by a strong series of quartz veins, which have a direction N. 67° W., with a dip generally conformable to the stratification of the rocks in which they occur. These veins are from a foot to over 100 ft. wide, and the more prominent ones occur at intervals of four miles across strike. The intervening belts are remarkably barren of veins. The veins themselves are barren looking and glassy for the most part. Yet places occur which show much evidence of decomposed pyrite, and in at least two cases the presence

of free gold accompanied by considerable quantities of galena has been established.

The sandstone country rock, especially near the quartz veins, is heavily impregnated with cubes of limonite pseudomorphic after pyrite. These vary in size from $\frac{1}{8}$ in. to 1 in. cubic, and are in such great abundance in the pay-streaks of the gravel that they add a burden to the work of cleaning up the sluices and tables. Beside the cubes there are also amygdules or orbicles of limonite of uncertain origin in some of the sandstone layers near the veins. No assays which have been made of the pyrite cubes or pyritiferous sandstone have showed more than a trace of gold; on the other hand some of the quartz assays well, and one outcrop near the Feodosievsky mine is now being opened up by the Lenskoi company for sampling. Several trials have in the past been made of quartz veins, but no promising results have so far been attained.

The concentrate which occurs with the alluvial gold is of no particular geologic interest. In the main, it consists of pyrite cubes with practically no magnetite. Several analyses have been made of the concentrate, but no minerals possessing special interest have been found. At the Svyetli property, one of the mines farthest east, the concentrate consists almost entirely of lime garnets. Assays of these fail to show the presence of more than a trace of gold. A honey yellow concentrate assumed at first to be monazite, which occurs in the barren granitic areas, was found on analysis also to be garnet.

Notwithstanding the pegmatitic habit of the granite and its enormous development to the south, no trace of tin-stone has so far been discovered. Mica has been mined in the granite. Float quartz containing wolframite occurs in the Vitim river below the mouth of the Bodaibo.

MINING CONDITIONS AND COSTS.—Despite its remote situation, the Lenskoi property has the advantage of cheap cost of living, supplies, beef, fish, flour, hay, grain, etc., being obtainable at prices little above those at Siberian towns along the railway. This is for the reason that extensive areas are cultivated, both in the upper Lena drainage, about Zhigalovo, and also far to the north, about Yakutsk, on the Lena, 700 miles below Bodaibo. Cattle on the hoof are driven to the property both from Yakutsk, and from Mongolia.

Power is furnished to the mines by six small hydro-electric plants, two of which have steam auxiliary, and one steam-electric plant. They are expensive to operate and inadequate in supply, and it is now planned to substitute a central plant on a neighbouring river where abundant power is available.

Freight rates from America or England to the property on machinery supplies may be reckoned at from $100 to $300 per ton (U.S.C.), according to size of pieces. The Lenskoi company has its own fleet of steamers and barges plying on the Lena and Vitim rivers, and 50 miles of narrow-gauge railway, connecting the Bodaibo mines with the small town of Bodaibo, where freight and timber are received on the Vitim. Beyond the northern terminus of the line, namely, the Feodosievsky camp, the communication to the eastward is by good wagon road to Nigri, 40 miles, thence only by horse trail to the more remote camps.

Several routes are now spoken of for giving more direct access to Bodaibo. One is the all-water route *viâ* Behring Strait and the Lena mouth, transferring freight to barges from ocean going ships at the Lena roadstead. It is estimated that large shipments can be landed at Bodaibo from San Francisco at Rs. 200 per ton, as against an average of Rs. 400 by the present method. One trip per summer of ships is possible. The sea transportation to Krasnoyarsk from England is already in practice *viâ* the Yenesei river. A rate of £4 per ship ton Hull-Krasnoyarsk is quoted by London shipping agents. The most practical route for connection with Vladivostok, is *viâ* Habarovsk, the Amur railway to Urumskoi, thence construction of an automobile freight-road 150 miles to the upper Vitim, thence down stream 500 miles to Bodaibo. Two rapids in the Vitim must be cleared of debris. The estimated cost is Rs. 1,000,000 to put this route into serviceable shape.

A second route from Irkutsk available *viâ* steamers to head of Baikal, 400 miles, and thence 300 miles by automobile road, to Bodaibo, will cost Rs. 3,000,000 to perfect. This route has been surveyed.

Talk has recently been heard about the extension of the standard gauge government railway from Irkutsh north to Yakutsk *viâ* Bodaibo, but it is not probable that this plan will bear fruition for several years. For passenger transport from Amur railway points to Bodaibo, air-craft will doubtless be employed inside a few years.

About 7300 men are employed at the mines and in all departments of the work, of which about a third are actually employed in mining gravel. The duty per man per 10-hour shift is a little over 1 cu. yd. It is estimated that

the duty has risen since last year, and it is thought that the vodka prohibition has something to do with it. From whatever cause, the duty per man employed is about 30% higher than in the preceding operation. A minimum wage scale of Rs. 1·60 per day obtains, but miners at the face on a contract basis make from Rs. 2 to 3·50 per 10-hour shift.

LOOKING UP VITIM FROM BODAIBO. THE LENSKOI COMPANY HAS ITS OWN FLEET OF STEAMERS ON THIS RIVER.
[Photo by W. C. Hand]

There is a population of about 30,000 people directly and indirectly dependent on the company for a livelihood. The company pays a flat wage, all men and employees feeding themselves. Company stores are operated, but no real profit is made from them. As in most parts of Siberia, these stores constitute rather a burden than otherwise. In their conduct, as in most other departments of the business, a disproportionate number of employees, clerks, book-keepers, foremen, watchmen, etc., are on the pay-roll. They form a portion of the heritage of over-staffing and inefficiency, which in the time-honoured methods of Siberian mine administration is always so conspicuous. Happily it is the aim of the present Lenskoi management to eliminate superfluous members of the force, and to raise the efficiency of the labour by every means possible.

EXTENT OF DEPOSITS.—The Lenskoi company, a consolidation of several old companies formerly operated separately, controls a larger extent of producing territory than any gold gravel mining company in the world. It also produces from two to three times as much placer gold as any other company or private operator in the world, and the present moment sees no prospect of a diminution of production. The main part of its product comes from the valley of Bodaibo river as it is called, really a creek, the average width of which is from 35 to 250 ft., and which has a length of about 60 miles. The present stream has no relation to the subterranean pay channels, these being from 200 to 1200 ft. wide. They follow courses which are sometimes hundreds of feet away from the present stream, and are buried under from 70 to 200 ft. of overburden of gravel, sand, and boulders. Surface pannings in the Bodaibo, or in fact any of the streams of the two districts, rarely give any results. These features are also characteristic of most of the other stream valleys of the district, from which gold has been produced.

HISTORY AND PRODUCTION.—The history of the region goes back to a time previous to the discovery of gold in California. In 1843 the first locations were made in the Olekma or northern district on shallow surface deposits, and in 1848, one Trapeznikof, produced about Rs. 35,000 worth of gold from the Vosnesensky claim on the Homolko creek. The Lenskoi company's first product was from the Nigri creek, in the Olekma district,

MAMUKAN RIVER, A TRIBUTARY OF THE VITIM NEAR BODAIBO, SEEN FROM THE MOUTH OF DODYCHTA.
Photo by W. C. Hand]

in 1863.* The company in fact continued to operate for a long time on that creek and the adjacent Ugakan creek, and did not produce from the Bodaibo until 1897. Long before this, however, Bazilevsky, Trapeznikof, and Michael Sibiryakof, the forerunners of the subsequent Industrial company, had been mining on Nakatami, a branch of Bodaibo creek. In 1863 Michael Sibiryakof located the Blagoveshensky claim on the Nakatami, a stream which with two of its tributaries has

* The Lena district was first described by Taskin (*Mining Journal*, St. Petersburg) in 1865.

had a record of about £20,000,000 in a total productive length of 20 miles.

Up to the end of 1914, the recorded product in alluvial gold of the Vitim and Olekma districts has been £54,000,000 in round figures, while the additional amount of gold which came from the creeks, and was more or less illicitly disposed of, may be placed at not less than £30,000,000. The recorded product of the claims now under Lenskoi control has been about £40,000,000.

An estimate that I made of the product of the two districts up to the end of 1911, according to the records compiled by Sadovnikof, gave 27,500 poods of gold dust and nuggets. At an average fineness of 0·885 fine, the average recovery from the pay gravel worked was 11s. 8d. per cu. yd. The total yardage of 'pay' mined and washed was 85,000,000 cu. yd. Since then it may be estimated that the total has been brought up to 88,000,000 cu. yd., the bulk of this being from underground work. The average depth of the shafts through which the pay gravel is extracted is from 70 to 115 ft., and the pay-gravel is of greater thickness than is usual in other alluvial districts, being from 6 to 9 ft., with an average of 7 ft. In certain stretches of the Bodaibo, 'pay' has been worked beneath an overburden of 250 ft., but this is rare.

Perhaps the richest area of placer ground of whose exploitation there is record in any country, was worked on Nakatami creek between the years 1868-78, and to a less extent down to 1904. This was an area near the junction of the Nakatami and Akanak-Nakatami creeks, about two versts above the Bodaibo. The ground was mainly on the Rozhestvensky and Blagoveshensky claims, with a small fraction of the Uspensky. The dimensions were about 3600 ft. length by 360 ft. breadth by 70 to 110 ft. depth, the 'pay' composing the lowest 7 ft. The bedrock lay at an elevation of about 70 ft. above the water of the Nakatami, being really a bench on the left limit of that stream. The overburden was in the main frozen, and was worked by the method of thawing with wood fires, stripping with pick and shovel, and removing with carts. The number of years during which the work went on is evidence of the slowness of the methods. The gravel was carted to crude trommel washers run by water power, and the tailing was again carted away from the discharge flumes. The product from the area named, officially recorded, was 668 poods, worth £3,120,000, from 1,000,000 cu. yd. of pay-gravel. This gives an average recorded recovery of £3. 2s. 5d. per cu. yd. There is no question that this was not the full recovery, but it was all the Industrial company received. The acreage was about 30, consequently the value per acre of this tract was £104,000, or £860 per running foot, or £2. 8s. (say $12) per square foot of bedrock. This for 1,296,000 sq. ft. constitutes the record for placer ground, so far as I am aware.

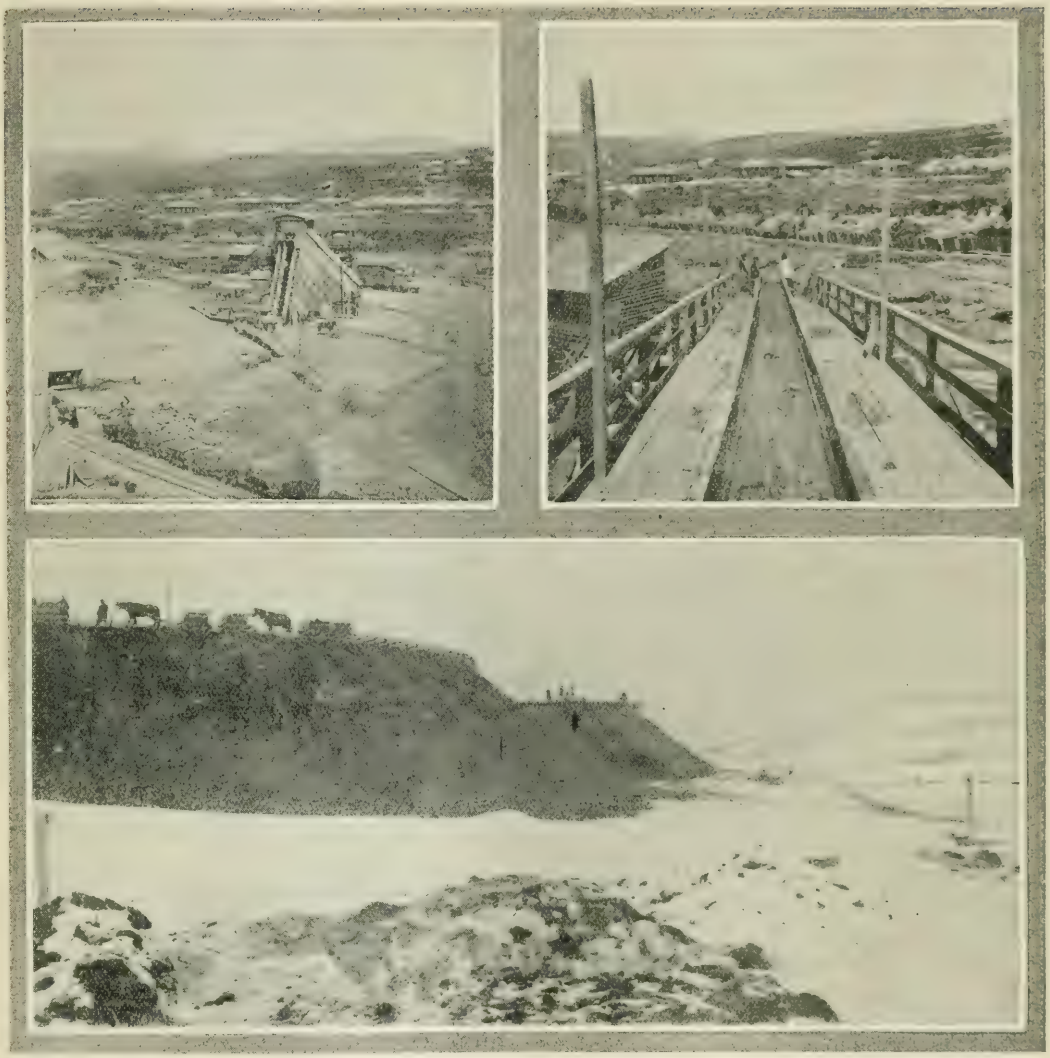
The present Lenskoi area worked on the Feodosievsky is far wider than was the area above described. It is curious that the Feodosievsky claim on the upper Bodaibo was one of the earliest worked by the Lenskoi company, yet its rich bonanzas were not discovered until about 1910. In places the pay channel on this and the neighbouring Sophisky claim is 1200 ft. wide, and the part at present worked is from 700 to 800 ft. The average depth of the 'pay' averages 7 ft. It is covered by 100 to 115 ft. of overburden. From the richest gravel on the property, mainly coming from shafts 4 and 5 Sophisky claim, the average recovery has been for 53,450 cu. yd. mined, hoisted, and washed during this season (up to March 23, 1915), £3. 13s. 7d. per cu. yd., or at the value of the gold, 19·7 pennyweights.

During the season of summer washing, which begins about April 15, it is expected that there will be washed about 650,000 cubic yards.

All ground is thoroughly prospected before drifting, the Lenskoi company at present operating about 20 Keystone drills. The drilling conditions are difficult, some of the holes being 250 ft. in depth.

The present product comes mainly from a stretch of 20 miles of the Bodaibo creek, the bulk of it from portions of three claims, the Sophisky, Baikalsky, and Efermerny, at the forks of the Bodaibo with the Big Dogaldin creek. Other mines are the Nizhni, Prokopievsky, Andreyevsky, Nakatami, and Bodaibinsky, all in the Bodaibo drainage, and the Nigri, Svyetli, Kulibranik, and Bulbuchta, which last are at distances from 40 to 150 miles to the east of the main Bodaibo camps.

Altogether the Bodaibo and its producing tributaries total approximately 100 miles in length, and it may be said that from nearly every mile of this distance some gold has been produced in paying quantity, while large areas within its drainage remain to be prospected. No single stream drainage in Alaska or the Klondike, so far as I know, has yet approached Bodaibo creek, either in produc-



ABOVE ARE SHOWN THE NEW ALASKA-TYPE SLUICES WITH THE MECHANICAL ELEVATOR FOR TAILING; BELOW IS ILLUSTRATED THE OLD MANNER OF PILING UP WINTER DUMPS.

tion or in continuity of pay channels. The open-cut work is of subordinate importance, such work being conducted only on the creeks of the more isolated part of the property.

The total product from the company operations during the season 1913-14 amounted to £1,277,000 in round figures, from 873,675 cu. yd., and the product of this season is expected to exceed this figure. In addition to this the company purchased from tributers and other outsiders gold to the amount of over £200,000. According to the Bodaibo government assay office returns, the entire amount of gold purchased from October 1, 1913, to January 1, 1915 (o.s.) was Rs. 19,570,000. This would be at the rate of about £1,700,000 annually. Taking into consideration the amount of gold which is carried out of the district and sold either at Irkutsk or at points even farther away, it may be estimated that at present the Vitim and Olekma districts are affording about £2,000,000 annually in alluvial gold.

While beside the Lenskoi company there are three or four smaller companies and various individuals producing, it is a moderate statement to say that 75% of the gold produced comes from ground controlled by the Lenskoi company.

METHODS OF MINING.—Within the winter just closing, a process of winter washing has been successfully applied which is conducted in the following manner: A string of sluice boxes of the type ordinarily used at American placer mines was erected near the shafts from which the bulk of the gravel was mined. The dimensions of this sluice are 28 in. wide, by 17 in. high, by 175 ft. in length; the grade is 14 in. to 12 ft. The riffles are steel rails longitudinally disposed, laid in the sluice in inverted position, the space between being 1½ in. These alternate with Siberian grate riffles of a rather obstructive character. It is planned as soon as practicable to use an alternation of steel rails and angle iron riffles. At the foot of the sluice a chain of buckets lifts the tailing to a height of about 40 ft. above the bottom of a sump, the tailing being de-watered before raising. The tailing is dumped directly from the elevator as long as possible and then trammed by gravity with cars and distributed in heaps. The entire structure is enclosed with a log housing. Water for sluicing is obtained by gravity, and the elevator is operated by an electric motor consuming about 15 hp. Quicksilver, which hitherto has never been distributed in the sluices, is to be used. The company is at present installing retorting furnaces preparatory to using it in all the gold-saving appliances.

For the first part of the financial year, 1914-15, commencing with the Russian October, 1914, and extending to March 10/23, 1915, the figures for winter washing are available. The portion of the gravel which is directly washed in winter constitutes only about 25% of the entire annual output. The amount mined up to March 10 was 421,568 cu. yd., while only 190,851 cu. yd. was washed. It is expected that 890,000 cu. yd. will be mined and washed from the entire property for the year running up to October 1/14, 1915, of which about 825,000 is from drift mining, and 65,000 from open-cut work. From the 190,851 cu. yd. mined, hoisted, and washed, up to March 10, there were recovered 104,643 oz. of gold dust and nuggets, worth, at £3. 14s. 8d. per ounce, the sum of £390,633, or 40s. 11d. per cu. yd. This work was done during intense cold. Advices from the property state that in January some days recorded a temperature of 74° F. below zero. The cost of the winter washing, including hauling from the shaft mouth to the head box, washing, and disposing of tailing, amounts to approximately 1s. 5d. per cu. yd. The cost of this work can be lessened as time goes on.

Sluices of this type have also been introduced at Lenskoi in the past two years for summer washing, although up to the present no automatic distribution of tailing by gravity has been attempted. The figures show a sluice erected for 1914 summer work in which about £200,000 sterling was recovered. These sluices have in a large measure supplanted the stationary washing plants of the trommel pattern and the Siberian type of sluice or *kulibina* formerly used at the property. It is found that the saving of gold is fully as high as in the old types, and the amount of labour consumed in the washing is much less. The company's engineers are at present engaged in plans for considerable reduction of working cost, both in the mining and washing of the gravel with their attendant operations.

CHARACTER OF THE GRAVEL. — The pay-gravel is characterized by irregular and sub-angular pebbles and boulders, and large fragments of bedrock. The average size of the gravel is from 6 in. to 1 ft. diameter, but slabs of bedrock up to several feet in length are frequently included. This renders the expense for dynamite high. Bedrock is also taken up from two to three feet. The richest gravel is in thin layers, from two to three inches in thickness and sometimes running 50 or 60 oz. per cu. yd. The gold, in size from a pin head to a small pea, is visible in the midst of a brown mass of limonite cubes, pseudomorphic after pyrite. A candle run along the streak will show the gold specks glistening among the wet brown pyrite. These streaks are perfectly loose, and there is in fact almost no clay of any kind in Lenskoi gravel. Cemented gravel is only occasionally encountered. A sampling of an especially rich pay layer from top to bottom of the section was as follows:—

	Inches.		Value per cu. yd. Rs.
Upper	10	.....	1·98
Next	45	.....	112·82
,,	45	.....	27·76
,,	3	(in bedrock)	2·95

Large nuggets do not characterize the richest gravel. Nuggets are found in workings which are generally below 'pay' value or just on the verge of non-pay. The explanation is that the nests of nuggets were derived from glassy veins which are otherwise barren, while entirely different veins, containing finer gold, evenly distributed, furnished the placer gold which now forms the regular bonanza layers.

The pay-gravel in general varies from 4 to 7 ft. in thickness. Cases are known where

gold-bearing gravel has a thickness of as high as 20 ft. In these cases, as for instance the ground being now worked near the junction of the Bodaibo and Nakatami, the value is generally too low to pay, as the gold is not sufficiently concentrated, and the attempt to work such ground by drift mining is not successful.

In most places the 7 ft. of pay-gravel is covered by from 5 to 15 ft. of fine rounded gravel. Above this is from 20 to 40 ft. of black silt containing large irregular boulders of the same nature as the bedrock below. Still nearer to the surface is another layer of rounded gravel of the size of paving stones and of irregular thickness. The surface, to a depth of from 15 to 25 ft., consists of the ordinary 'muck' overburden and fine stream gravel. The surface blanket of sub-angular pieces of rock which is strewn over the valleys and whose origin is attributed to an annual glaciation, is elsewhere mentioned.

It may be seen from the above description that the average character of alluvium is not suitable for dredging operations. Bedrock is in the main rough and uneven, in cases having obliquely disposed waves or corrugations of 20 ft. from crest to crest, and of 7 to 10 ft. from the top of one crest to the bottom of the interval between two crests. This is particularly the case in the valley of the Nigri, one of the isolated mines. A misconception exists as to the amount of permanent frost in the gravel of the Vitim and Olekma districts. This really is comparatively an insignificant

QUARTZ OUTCROP ABOVE FEODOSIEVSKY MINE, BODAIBO CREEK. "THESE VEINS ARE FROM A FOOT TO OVER 100 FT. WIDE."
[Photo by W. C. Hand]

THE BODAIBO-DOGALDIN DIVIDE, 4000 FT. ABOVE SEA LEVEL, ILLUSTRATING THE CHARACTER OF THE COUNTRY ROCK.
[Photo by W. C. Hand]

feature. It is in fact the thawed or only partly frozen character of the alluvium which renders mining more difficult than in the Fairbanks or Klondike districts of the American North. Layers of permanent frost are encountered in the vertical section of the alluvium, alternating with thawed and water bearing layers. This condition renders any form of exploitation all the more difficult. It is a far more difficult condition than would be the case if the ground were permanently frozen from top to bottom, as for example, in the Fairbanks district of Alaska. Solid permanent frost is a help in the drifting of ground, as little timbering is required. On the other hand so much timber is required in Lenskoi workings that this expense forms about 33% of the underground cost.

It is estimated that at least £3,000,000 worth of timber has gone into the underground workings of the Bodaibo, and it is doubtful if any of this old timber would be serviceable even if recovered. Timber is now being recovered as work progresses, and it is planned to recover at least 50% of that which hereafter goes into the workings, by an introduction of the longwall and caving system.

The ground requires close lagging, and virtually square setting beside. It is true the Russian law requires heavy timbering, but the heavy ground of the Bodaibo could not be supported by any but the heaviest and closest timbering. Of this one has no doubt who has once inspected the ground.

Possible Future Developments.—It will be seen from the above description that the Vitim gold district, one of the richest, if not the richest of known alluvial deposits, has an extremely complicated and irregular character, and that it does not appear to have been prospected except to a limited extent. The tracing out of the old channels will undoubtedly lead to the discovery of entirely new and unexpected creek deposits. These are necessarily of sporadic occurrence, and if a rule of occurrence can be arrived at, it will be the work of several years before such a rule can be formulated. While drift mining has so far been the method pursued, it is fortunate that the district possesses an abundant water supply, as in the future it is thought that hydraulic methods can be applied.

The sharp cutting off of many of the old channel deposits lying high on bedrock benches, flanking present streams, would render their exploitation by hydraulic methods possible. The character of the alluvium in these benches is similar to that found in the creeks, and in more than one instance, gravel benches have been profitably exploited by hand methods. One of these benches was worked on the left limit of the Bodaibo, near the mouth of Nakatami creek. Here the gravel worked by drifting rested on a rock-floor having an elevation of 125 ft. above the level of the creek. These benches which appear to be of great extent in the region may be compared to the White Channel benches of the Klondike. Before considering the exploitation of these benches, however, the company must in the future consider methods of re-working the creek gravels, since many areas which 20 or 30 years ago would not pay can probably now be bought into the pay-gravel class.

There are many miles of such partly worked-out areas which it is now planned to drill with a view to future exploitation by some form of open-cut method. It has been ascertained that the overburden frequently contains auriferous layers, and the creek contains fine gold which has in the course of years been carried far down from the former imperfect washing operations. Beside the known areas the Vitim and Olekma districts contain hundreds of creeks which are virtually unexplored. Prospecting is difficult and expensive owing to the distances from base of supplies which must be traversed. It will doubtless be many years before the resources of this portion of Siberia are even approximately known.

A history of the pioneers of the Yeneseisk, Vitim, and Olekma districts would be of romantic interest. One regards today with amazement the energy and perseverance exhibited by the early miners who in the 40's, 50's and 60's made their way 5000 miles from St. Petersburg by sledge with tools and supplies and produced gold in these remote forests. The names of Sibiryakof, Trapeznikof, Nemchinof, Solovief, and Bazilevsky, those intrepid prospectors of the Lena, deserve credit and honour from the Russian people.

The Discoverer of Gympie.

On March 6 a memorial, taking the form of a drinking fountain, was publicly inaugurated at Gympie, South Queensland, in honour of James Nash, the discoverer of gold in that district. Nash arrived in Queensland in 1858 as a young man of 24, and being of a roving disposition travelled in various parts as a prospector. He had no luck for some years, but he was encouraged to start again in 1867, by the offer of £1000 on the part of the Queensland government for the discovery of a goldfield. At that time Queensland was far from prosperous, banks were failing, and many communities were on the verge of starvation. The government desired to encourage prospecting for gold, hoping that a discovery would put matters straight. The beneficial effects of the goldfields in Victoria and New South Wales were viewed with envy. Nash started alone from Nanango, about 90 miles north-west of Brisbane, travelling in the district round Mount Stanley and Yabba. After visiting Brisbane for supplies, he went down Mary river. At the place now called Gympie he was rewarded by the discovery of alluvial gold. After collecting a few ounces, he was obliged to go to Maryborough, at the mouth of the Mary river, in order to renew his tools, for which he paid in gold dust. He went back to his diggings, and collected 75 oz. of gold, which he sold at Brisbane for £200. Returning again, he continued to find gold, and then decided to make the necessary legal declaration of discovery. This he did at Maryborough on October 16, 1867. He called the place 'Nashville,' but unfortunately the name was not officially continued, a fact to be regretted from the gold-miner's point of view. On the news of the find spreading, a rush at once ensued, and many fortunes were made. Nash extracted £7000 in gold from his claim, and obtained the £1000 reward from the government. Comparatively speaking, his share in the riches of the district was small.

SEPARATION OF WOLFRAM FROM TIN

At East Pool, in Cornwall, the wolfram concentrate produced by the Wetherill magnetic separator is further treated for the removal of adhering cassiterite particles, the cementing oxide of iron being dissolved by the action of an acid solution, and the material then re-treated magnetically.

By M. T. TAYLOR.

SEVERAL of the mines in Cornwall contain both tin and wolfram. Among those that do is East Pool & Agar, situate at Carn Brea, midway between Redruth and Camborne. This mine has been worked for over 80 years, principally for tin. The average recovery of the mineral contents of the ore mined during 1914 was:

	Pounds per ton
Black tin	17·60
Wolfram	2·95
Arsenic	12·50
Copper	0·55

Owing to the specific gravity of the tin and wolfram being so nearly the same, considerable difficulty was experienced in making a separation, and all attempts to do so by wet and dry concentration were rewarded with very poor results. The advent of the magnetic separator ten years or so ago has done much to mitigate this difficulty, so that now complex ore of this nature can be treated in a satisfactory manner. The general procedure has been described on previous occasions. The mixed concentrate from the tablesand buddles, after being roasted for the expulsion of sulphur and arsenic, is sent to a Wetherill separator, where the iron is first removed by a weak magnet, and afterward the wolfram removed by a stronger magnet. The point that has caused trouble in this system of treatment is that the wolfram concentrate contains a good deal of cassiterite, which adheres to the wolfram, the cementing agent being oxide of iron. At East Pool we have introduced a so-called pickling process, whereby the oxide of iron is dissolved by acid. The material is then re-treated magnetically, and a final separation of the tin and wolfram effected.

As the treatment of wolfram-bearing ores is of particular interest at the present time, a general account of the concentrating plant at East Pool may prove acceptable. The ore, on coming from the mine, is put through two rock-breakers, after which it is conveyed to the mill by electric haulage. It is then passed through 10 Holman pneumatic stamps, 15-mesh screens being used. The pulp goes direct to hydraulic classifiers, the underflow from these going to 26 Wilfley tables and the overflow into de-waterers. The underflow from these de-waterers is conveyed over revolving slime-tables and the overflow used as wash-down water. The middling from the 26 Wilfley tables is conveyed through 2 large tube-mills, and the pulp from these fed to 20 Frue vanners. The tailing from these vanners passes to de-waterers,the underflow from these going to revolving slime-tables, while the overflow is used for wash-down water. The whole of the concentrates from the various concentrating machines is put through 5 Brunton roasting furnaces to eliminate the sulphur and arsenic, special chambers being constructed to save the arsenic. The slime and rough concentrate are burnt in separate furnaces. The slime concentrate, being the most difficult to treat, after passing through the roasting process is automatically fed into a Frenier pump, where it is lifted into hydraulic classifiers, the underflow from which passes to a James sand-table. By this means all the rough and coarse particles of sand and tin are removed before passing on to the slime-tables. The overflow from the hydraulic classifiers is fed into 3 de-waterers. The underflow from these is discharged upon 3 James slime-tables, and the overflow is used as wash-down water. The middling from these tables passes into pulverizers, and again joins the main flow, forming a continuous circuit, while the tailing is lifted and passes over revolving slime-tables. The rough concentrate after being roasted is passed over buddles. The tailing is put through 4 Holman grinding-pans, and the product from these is lifted into hydraulic classifiers, the underflow again passing over James sand-tables, and the tailing being returned to the grinding-pans. The overflow from the hydraulic classifiers passes into de-waterers. The underflow from these is fed over 5 improved Wilfley tables, especially constructed for treating this product. The middling from these tables is ground in a pulverizer and then lifted into a de-waterer. The underflow passes over

2 Frue vanners, the tailing being elevated, and passing over 4 revolving slime-tables. The head concentrate from the various concentrating machines is collected and put through a drying plant. When this is completed the concentrate is ready for magnetic separation.

The concentrate at this point assays from 55 to 60% Sn and 10 to 15% WO_3. This product, after being dried, is elevated to a small bin and from there it is automatically fed to 2 Wetherill magnetic separators. These machines have a capacity of about 5 tons each per 24 hours. They are 4-poled machines with a main conveyor-belt running close under the poles, the poles being placed alternately north and south. There are also 4 cross-belts running at right angles to the main conveyor-belt and in contact with the bottom of the pole-pieces. These transverse belts are operated about $\frac{1}{8}$in. above the main conveyor-belt so that the magnetic force lifts the wolfram and other magnetic particles off the main conveyor to the under side of the cross-belts, where they are held until the cross-belt carries them out of the influence of the magnetic force, when they immediately drop into small chutes constructed on the side of the machine. The tin, being non-magnetic, passes along to the end, and is deposited in a receiving-bin at that point. The first 2 poles carry from 5 to 8 amperes, and take out most of the iron and other highly magnetic substances, while the wolfram, being only slightly magnetic, passes on to the next 2 poles which carry from 12 to 15 amperes. After this process the wolfram concentrate, which contains tin, is placed in lead-lined vats. These are about 8 ft. by 8 ft. by 3 ft. deep. About 3 in. from the bottom a filter-bed is placed. It is composed of perforated decking made of wooden planks with about 30 one-inch holes to the square foot. Over this is laid cocoanut matting. The wolfram product is spread over this and covered with a dilute sulphuric acid solution, the strength of the solution being 8 parts water and 1 part acid. It remains in these vats from 12 to 14 days. The solution is heated to about 180° F. If overheated the mass of concentrate will become cemented and separation will not be so complete. Lead tubing is coiled on the top of the wolfram, and into this steam is conveyed for heating purposes. This pickling operation has the effect of disintegrating the particles of wolfram which are, as already mentioned, cemented principally by iron oxide, from the tin, thus setting them free so that they can be separated when again put through the separators. After the pickling process is complete the acid solution is washed off and the wolfram product again sent through the drying furnaces and put through the magnetic separators. The amperage in this second operation is less than that used previously, the first poles carrying from 3 to 5 amperes, and the second 8 to 10 amperes. When this treatment is complete the average assays of the products are: tin oxide 68% Sn, wolfram 68% to 70% WO_3. Both the tin and wolfram are then in a marketable condition.

The Journey to Petrograd from London is at present made by boat from Newcastle-on-Tyne to Bergen in Norway and thence by train round the head of the gulf of Bothnia, the time occupied being $6\frac{1}{2}$ days. The train starts from Kings Cross at 2.30 p.m. and the boat leaves Newcastle at midnight, arriving in the afternoon, 40 hours after. The next stage of the journey is by train from Bergen to Christiania, leaving at 6.40 p.m. and arriving at 7.15 a.m. next morning. A change is made at Christiania into the train that goes, *via* Krylbo, to Karungi at the head of the gulf of Bothnia on the Swedish side of the Sweden-Finland boundary. This train leaves at 7.25 a.m., arrives at Krylbo at 9.34 p.m. of the same day, and at Karungi at 7.50 a.m., 48 hours after leaving Christiania. No connection by railway is made over the border with the Finnish railway system. In winter it is necessary to drive by sleigh over the Tornea river, join the train at Karunki, and proceed by a local train to Tornea, arriving about 12.30 p.m. In summer time the route is by road over a bridge at Hoparanda direct to Tornea. From the latter station the Petrograd train starts at 5.10 p.m., arriving at its destination at 10 p.m. the next day. On the Swedish railways it is not advantageous to book first-class, for the accommodation simply means obtaining a 2-berth compartment for one person, and as the trains are crowded it is often impossible to find a free compartment. It is best therefore to book 2nd class and, if by chance a compartment with both berths vacant is available, to pay the extra price. It is well to attend promptly to the securing of accommodation on the trains at Bergen and Tornea. Refreshments can be obtained at a large number of stations *en route*. Hand luggage and baggage are examined at all the frontiers, and though both have been examined at the Sweden-Finland border, they are again inspected by customs officials on arrival at Petrograd.

DISCUSSION

German Genius.

The Editor:

Sir—I have read with pleasure the article on 'German Genius' in your April issue, and the strong case you have made for a recognition of the position which the British and French have occupied in the world of science and progress. I note one mistake, however, which gives to Germany a claim to which she is certainly not entitled. You state (p. 200) that "Bessemer, the nominal inventor of the process bearing his name, was of German parentage. His experiments were failures until Robert Mushet of Sheffield showed him how to regulate the amount of carbon in steel." I have given an account of Bessemer's work in my 'Metallurgy of Iron,' Chapter III, and it will be found more completely in his own Autobiography, published a few years later. He was born at Charlton in Hertfordshire in 1813, and was the youngest son of a very ingenious French refugee. He was educated at Hitchin, and at the age of 18 was working in London as a designer and modeller. He was the real inventor of the process which bears his name, and it is very doubtful if Robert Mushet's patent could have been upheld, even if it had not been allowed to lapse.

THOMAS TURNER.

The University,
Birmingham, May 28.

Mining of Alluvial Deposits.

The Editor:

Sir—With regard to the criticism offered by Mr. Hancock in your April issue, referring to the effect of increase of head upon the duty of water in hydraulic mining, I wish to say that the statement appertaining thereto, made by Mr. Knox and myself, was entirely in accord with results obtained from our own practice. Not knowing whether Mr. Knox is at present in London, I wish to reply to this criticism for us both, as the matter was fully discussed between us at the time of writing.

An elementary law of hydraulics need not be re-stated in your columns, but to prove our point theoretically it may be cited. Velocity of water through a nozzle varies directly with the square root of the pressure upon it. Impact varies directly with the square of velocity, hence impact increases directly in proportion to increase of pressure, omitting friction loss in the pipe-line. When a giant is directed against a bank of gravel the cutting force of the stream is a function of its impact.

Any practical piper knows that his coarse material will move much faster if he keeps plenty of fines at all times mixed with his water. The greater the amount of sand and silt cut down from the bank, provided the lead water will keep it in suspension, the greater the duty of the water as a whole. In fairly free gravel this amount is directly proportional to the impact of the giant stream, which varies directly with the pressure. Other conditions being equal, the duty of water in free ground will be found to vary approximately with the head under which it is working, at times above and at times below the proportional factor.

My own preference in hydraulic mining is for high pressures wherever the conditions will permit, owing to the time saved in moving giants and relaying pipe. Bracing has to be a little more carefully done, but the operation does not have to be repeated so often. I have worked with heads up to 500 ft. and find them much more effective, especially in the field-giants.

CHAS. S. HALEY.

San Francisco, May 8.

Magmatic Waters.

The Editor:

Sir—In the summary of Professor Kemp's address to the Mining and Metallurgical Society of America, given in your February issue, page 108, reference is made to the water obtained from molten lava in Hawaii by Messrs. Day and Shepherd, as proof that molten rock may contain water. I am of opinion that certain molten slags may contain water. Probably every reverberatory smelter of the old school has had experience of frothy slags. In the course of many years smelting

of mixed quality ore, I have often found that slags generally considered basic, because low in silica, are always frothy if high in alumina. These slags apparently form easily (at least when zinc and lead are present), and are perfectly fluid and smooth-surfaced while in the furnace; but immediately they leave the furnace they froth up tremendously and emit comparatively enormous volumes of gas. I tried on several occasions to find out what this gas was. After proving it was neither oxygen nor carbonic dioxide, nor any hydrocarbon, I concluded it was steam. I noticed also that this phenomenon occurs only when the furnace is working very hot. Where did the steam come from? It must have come from the aluminous silicates contained in the gangue, which, in our case, was a tufaceous rock.

In the lava pool of Kilauea, as in our reverberatory furnace, there could be no excess pressure, so I take it that molten rock of a certain composition while at a very high temperature may contain much water which is emitted as steam at a very slight fall in temperature.

EDGAR HALL.

Silverspur, Queensland,
April 12.

British East Africa.

The Editor:

Sir—Members of the mining profession, like the rest of the British public, have not grasped the reasons why there is such a country as British East Africa, and do not fully understand what is implied by the letters 'B.E.A.' A few persons come out here to shoot big game in Nature's zoo, and some come here to try their luck with agriculture, but an American and myself are the only individuals who are trying to prove that this part of Africa is worth further investigation. As pioneers we have our work cut out, but we are far from being disheartened. Owing to the war, this part of Africa is getting some advertisement. You naturally may be inclined to ask why the country has been neglected, and why its mineral resources have not been tapped. One good reason is that even the ordinary resident here is under the impression that there are no minerals in the country. This impression was caused by the adverse report of a geological party, organized at a time when the British Government took over the country from the Imperial Chartered company. As this party devoted much of its time to looking for minerals in a modern lava-flow, the verdict may be technically correct, but the party was not keen on looking for minerals in country destitute of a good water-supply or infested with big game. I have never been able to get to the bottom of this business, but I believe that the party devoted a good deal of time to making the best of a free picnic; and that if its members found anything which showed signs of gold they were probably told to keep it dark, be cause the gold-miner is such an undesirable, and the local government officials would not like their siestas disturbed by wild Irishmen and energetic Australian diggers. The Magadi Soda Company is the only result of this original prospecting expedition, and I believe that even to-day the original discoverer is unrewarded. The people who financed this expedition came very tearfully to the governor and asked some form of compensation for their ill-luck in prospecting, and got a free grant of 500 square miles of lovely country, which they make a pretence of developing, although the land has certain agricultural potentialities. If all prospectors got kind treatment of this sort, there would be few real discoveries, and no one would be down on his luck. In the German colony to the south there are mines working, some gold and some mica, and I suppose in time all the common and some uncommon economic minerals will be found. For a period covering twelve months, I went to as many different localities near the Mombasa and Uganda railway, and gradually obtained a basis on which to outline a detailed examination, also getting into touch with people who were prospecting or trying to prospect. The average prospector here is a novice at the game, but I have found some encouraging indications, more than confirming my first impressions of the country. I was well on the way to being able to boast that I knew where to go for certain minerals in any part of British East Africa, when the war broke out. It was my intention to contribute eventually some articles on this part of Africa. Now I cannot look forward to the future with such confidence, as it would be difficult to tempt capitalists to look at unproved countries unless there was something tangible to show them. But I am convinced that this part of Africa will come to be regarded with more kindly consideration, and that it will be a self-supporting country in the true sense of the word, just as Australia is today.

ERIC J. STAREY.

Mombasa, March 9.

PRECIS OF TECHNOLOGY

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.]

Geology of the Portuguese Congo.—In the *Geological Magazine* for May, Arthur Holmes describes the geology of northwestern Angola. This territory is often called Portuguese Congo. Its coast extends from Loanda to the mouth of the Congo, and a small isolated section, known as Cabinda, lies to the north of the western extremity of Belgian Congo and to the south of French Congo. As this part of the world is the scene of much mineral investigation, and as copper has been found at Bembi and Senza do Itombe, Mr.

Holmes' paper is of timely interest. The chief previous investigators have been Cornet, who described the western tongue of Belgian Congo, and Colonel F. d'Andrade and J. J. MacHugh. Practically the whole of the literature hitherto published in connection with the territory is in the French or Portuguese language.

It will be seen from the accompanying map that the country is divided into three belts approximately following the coast-line. The middle belt consists of a complex of Pre-Cambrian gneisses and schists, intruded by granite, pegmatite, and diabase. Between this belt and the coast, and lying on the Pre-Cambrian rocks, are Cretaceous and Tertiary beds forming the coastal plain, while to the east the plateau of the interior consists of Paleozoic rocks probably Silurian, also overlying the Pre-Cambrian. The Pre-Cambrian rocks contain copper ores at several places. More important copper deposits are found in the Silurian beds. In the Belgian Congo tongue, the Silurian beds may be divided into two series. The lower series, called by Cornet the Bembizi beds, consist of conglomerates, calcareous sandstones, shales, and slates, and the upper series consist of 'schisto-calcareous' beds, made up of dolomites with chert bands. Their prevailing dip is away from the coast toward the central part of the Congo basin. Over the Portuguese border, between San Salvador and Bembi and southward to Kiballa, the lower rocks are represented by arkose, quartzite, and calcareous sandstones, and the upper rocks by dolomites and limestones. At Bembi are found copper ores of great promise. To the south of the region described by Mr. Holmes, the same Silurian rocks are found; they extend through the whole of Portuguese West Africa into Damaraland, where the dolomites at Otavi have yielded rich copper-lead ores worked by the well-known German company. At Bembi and Otavi the copper ores occur in the same way as those at Kambove in the Katanga region farther inland.

On the Quanza river, and around Dondo, on the western side of the Pre-Cambrian complex, there is a coal-bearing formation, probably of Lower Karroo or Permo-Carboniferous age. This formation contains oil-shales and a thick seam of coal. The greater part of the western belt consists of Cretaceous, Eocene, and Miocene beds, which in turn are largely covered by alluvial deposits and lateritic sands and gravels. To the south are found Tertiary lava-flows, in the region between Senza do Itombe and Bango. These have penetrated both the Karroo and Cretaceous rocks. It is here that other copper deposits are found.

Tin-Dressing.—At the May meeting of the Institution of Mining and Metallurgy, a paper was presented, written by the late J. J. Beringer, describing his investigations by means of the microscope relating to the size and behaviour of cassiterite particles in Cornish tin ore, and the mode of association with quartz, tourmaline, and other gangue-minerals. The difficulty of arresting slime-tin by means of any concentrating apparatus is of course well known, but as it is not practicable to make a screen finer than 200-mesh, little has been hitherto done to ascertain the exact size and nature of the finest particles of cassiterite, and to account for their loss in dressing. The late Mr. Beringer undertook this study, by aid of the microscope, and the paper is the outcome of his experience.

Mr. Beringer found at the outset that the particles are so small that it is necessary to use the micrometric unit, μ, or one-thousandth of a millimetre. The standard I.M.M. sieve, having 200 holes to the inch, has holes with sides one-fourhundredth of an inch long. In micrometric measurement the particles of 200-mesh have a mean diameter of 60 to 65 μ. According to Mr. Beringer's system of classifying different sizes, he found it convenient to call everything larger than 120-mesh 'sand,' that from 120 to 200-mesh 'fine sand,' 50 to 100 μ 'very fine sand, 10 to 50 μ 'silt,' 5 to 10 μ 'fine silt,' and 5 μ or under 'clay.' It will thus be seen that Mr. Beringer sub-divided what is usually called slime into four separate products. Investigations were made with concentrates obtained at the King Edward mine, belonging to the Camborne Mining School. Here the pulp coming from the stamps is separated into four parts in a classifier, the first underflow going to a Buss table, the second to a Frue vanner, the third to an

Acme round slime-table, and the overflow to rag-frames. The particles in the Buss concentrate were found to vary in size from 50 to 150 μ, with an average of 100 μ; those in the Frue concentrate 25 to 95 μ, with an average of 60 μ; and those from the Acme and rag-frames 5 to 45 μ with an average of 25 μ. The slime sold by Dolcoath was found to consist of particles ranging from 5 to 50 μ with an average of 25 μ.

A series of experiments were made with different apparatus with the object of ascertaining the minimum sizes of particles recoverable by water-concentration, and other experiments were made as to the rate of settlement both in still water and in upward currents. The general inference is that above a diameter of 25 μ settlement and recovery present no great difficulty, while below that diameter the chance of recovery rapidly decreases. It is worthy of remark that particles so small as 5 μ are recoverable if they are mixed with particles of larger size, this result obtained by Mr. Beringer confirming the general experience of tin-dressers, and subverting the more modern school of exact sizing. Another series of experiments were made, with the object of ascertaining the effect on settling of the shaking motion of vanners and tables. With Buss tables it was found that the settlement of particles having diameters from 25 to 30 μ was greatly retarded, while particles less than this took a very long time to settle. With Frue vanners, having a gentler shake, the limit was about 20 μ. The shaking action of these machines therefore hinders the recovery of the finest particles.

In the second part of his paper, Mr. Beringer gave the results of his examination by means of the microscope of the mode of occurrence of fine cassiterite. The most interesting record is in connection with clouds of cassiterite dispersed through small quartz crystals, the clouds under the highest powers being resolved into fine clusters. Such quartz crystals have the appearance of particles of cassiterite, yet the proportion of cassiterite is small. These minute cassiterite grains are described by Mr. Beringer as being immature crystals caught and absorbed at their birth by growing quartz crystals. The general inference from the studies is that a large amount of cassiterite is distributed throughout the ore in a state too fine for recovery by water-concentration, and that the stamps or other crushers are not entirely responsible for the irrecoverable cassiterite in the pulp.

Metallurgical Practice on the Rand.—In the *Bulletin* of the American Institute of Mining Engineers for May, F. L. Bosqui summarizes recent changes and present practice in gold saving on the Rand. He considers the history in two periods, that before 1890 when saving was by amalgamation only, and the subsequent 24 years in which cyanidation has played so important a part. He notes the increasing reliance placed on cyanide, but sees no probability of amalgamation being abandoned. Ore sorting and breaking has not settled down to any standard practice, though there is a tendency toward adoption of gyratory as against jaw crushers. Stamp milling is fairly standardized with stamps restricted to crushing and ranging in weight from 1500 to 2000 lb. In amalgamating work, stationary plates are evidently preferred, and there is a movement toward placing them below the tube-mills, which greatly simplifies mill control. In regard to tube-mills, which the Rand was slow to adopt, the principal variation is in the ratio to stamps and methods of discharge. The peripheral discharge is considered an important improvement and note is made of a ball chamber placed between the main crushing section and the outflow to reduce small, spent pebbles, at the Rand Mines. The diaphragm cone followed by the Caldecott sand-filter table is considered a notable feature of the improvement in classification, but an arrangement of cones with or without Dorr thickeners is considered a satisfactory alternative. Introduction of vacuum filtration, one of the notable improvements of recent years, together with tube-mill grinding and improved classification, have made possible (1) the treatment of a greater portion of slime, which has improved total extraction and reduced costs, and (2) the treatment of more finely ground sand with consequent improvement in extraction. In the best plants, sand recovery is estimated at 90%, slime 93%, and total 96%. This is regarded as the highest extraction economically possible on the Rand. In slime treatment there are two processes, decantation with circulation by means of centrifugal pumps, and agitation in Pachucas followed by Butters filters. In precipitation, despite its admitted shortcomings, the use of zinc shavings remains dominant. The Merrill zinc-dust process has been introduced at the New Modderfontein, Modderfontein B, and Brakpan, with notable economies in labour and zinc, and many incidental improvements. Unfortunately these have been offset in large part by increased cyanide losses since it was found necessary, in order to secure good precipitation, to strengthen the solutions beyond the point fixed by economic extraction. At the New Modderfontein the use of zinc shavings has been resumed, but at the others the use of zinc-dust is continued. Mr. Bosqui considers that in this department there is large field for further improvement.

Oil Chances in South Australia.—The Geological Survey of South Australia has published a report by Dr. Arthur Wade, entitled the 'Supposed Oil-bearing Strata of South Australia.' As is indicated by the title, the chances of finding petroleum are remote. Dr. Wade spent five months, in association with L. L. Wrathall, examining every alleged prospect, and studying the geology of the various districts. The country covered extended over a great part of the coastal region, including Kangaroo island, and Yorke peninsula, and also two tracts north of Adelaide. He found that the so-called indications of petroleum consisted either of asphaltum found on the sea-shores, cooerongite, a sort of mineralized caoutchouc, or the iridescent films of hydrated oxide of iron on mud-springs. The geological conditions are not favourable, for the surface rocks, though porous and of Tertiary age, are shallow and horizontal, with no folds, and with no overlying impervious stratum. They rest directly on contorted Pre-Cambrian rocks, which have been intruded by granite. In the southeast district, near Mount Gambier, Tertiary basalt has risen through lignite beds, but no proof of the existence of liquid or gaseous alteration-products has been presented.

Dr. Wade gives an account of the geology of the country examined. The accompanying section gives a general scheme, though the later rocks are not all in evidence in every district. The Recent æolian sands generally partake of the nature of the underlying rocks, being usually calcareous on the coast and more silicious in the inland dunes. In many places the sand-hills are cemented by calcareous matter, and are included in the Upper Tertiary. Below these comes travertine, a limestone varying in consistence from solid to cellular and cavernous. In the Tertiary are also found lateritic ironstone, sands, clays, and lignite, with basalt intrusions in Kangaroo island and in Mount Gambier district. In some places, glacial clay, of Permo-Carboniferous age, and apparently con

temporaneous with the Gondwana beds of India and the Malay peninsula, are found, and sandstones, shales, and conglomerates of presumably Cambrian age are reported on Kangaroo island. But the total depth of all these rocks is small, and, underlying them, and also over a great proportion of the surface, are Pre-Cambrian schists, sandstones, quartzites, and gneisses, with granites and other igneous rocks. On the West Coast and on Eyre's peninsula, the so-called oil indications consist of asphaltum, which is found in

many places on the shore or near the sea. The evidence points to it having been deposited from the sea and that it did not originate from any rock. In many tidal flats, black organic mud is found, and it emits a sharp unpleasant smell that has been mistaken for that of kerosene. Dr. Wade shows that the smell emanates from the decomposition of organic matter, and is often due to the release of gaseous sulphur compounds. The idea that some of these occurrences are of the nature of mud volcanoes is quite erroneous. The local theory that some of the carbonaceous matter found on the coast came from the granites or Pre-Cambrian quartzites and schists was also investigated by Dr. Wade. He found that such a theory was untenable, and that, without doubt, the carbonaceous matter had been washed by the sea into cavities in the rocks.

On Kangaroo island, asphaltum has been washed-up on the southern and western shores, and the conditions as regards origin are much the same as those in Eyre's peninsula. On the Yorke peninsula, so-called indications consist of hydrated ferric oxide mingled with salt water, and no gas or oil is found. At one point close to Cape Spencer, a smell of kerosene was observable, but diggings and borings revealed nothing further.

In the northern part of the southeastern district, asphaltum is again the chief indication, and springs containing decomposition products of vegetable matter are plentiful. Here also is found coorongite, which however, is obviously of current vegetable origin. In the southern part, beds of lignite are found, pierced by basaltic lava flows of Tertiary age. The conditions here might be favourable, if any traces of gas or oil were found in bores, but so far any bore sunk has not been rewarded by any such indications. As regards the isolated districts inland, north of Adelaide, wells sunk at Leigh's Creek for water proved the existence of oil-bearing shales of Jurassic age at depths of about 1000 ft. At Coonanna, near the New South Wales border, an inflammable gas came from a water-bore. Near Lake Eyre, other water-bores penetrated oil-shale and coal, but neither gas nor oil came to the surface. In summarizing his experience, Dr. Wade states that more information is required before it is possible to say whether the basalt eruptions created any available oil

or whether such oil still exists. He considers that possibly the inland oil-shales might yield sufficient quantities of oil after being mined and distilled, though he doubts whether such a process would be profitable. As for free oil, he sees no chance whatever.

Coal-Dust in Reverberatory Furnaces.—Supplementary to papers presented at the February meeting of the American Institute of Mining Engineers, there is an interesting and informing discussion in the May *Bulletin* contributed to by E. P. Mathewson, D. H. Browne, J. B. Herreshoff, J. W. Richards, H. S. Munroe, W. D. Leonard, and others. The marked decrease in cost of smelting is shown to be due to a number of factors, among which the more efficient burning of the coal is most important. The incidental coincident introduction of feeding through holes along the top at the side of the furnace is a second important factor, since it makes possible the use of a greater part of the radiated heat, the flame now being surrounded on all sides save the top by ore. Mr. Mathewson described a method of tapping at the front of the furnace, letting the slag flow continuously and draining the matte at intervals through a hole 18 in. below. At intervals of eight hours the unfused ash is skimmed off through the front door. A new furnace is 144 ft. long and 25 ft. wide inside, and is working satisfactorily.

Composition of Mine Waters.—In *Economic Geology* for February-March, Edwin T. Hodge presents a paper containing the analyses of the circulating waters of a great number of sulphide-ore mines in all parts of the world. His object in view has been to classify information of this character that would help to elucidate the theories of sulphide deposition and re-deposition. He has been able to classify the waters into five divisions. The first have an acid-reaction due either to the presence of free sulphuric acid or to the hydrolysis of sulphates. These waters are carriers in the processes of sulphide enrichment. The second class are neutral or only faintly acid or alkaline, and calcium sulphate is the dominant salt, sometimes with a large amount of sodium chloride and sometimes with calcium carbonate. It is inferred that these waters have been collected either below ground-water level or at great depths. The third class resemble the shallow waters from regions containing little or no sulphide. If near the surface, calcium carbonate is plentiful, and if at depth sodium chloride is abundant. The fourth class are alkaline, hot, and ascending, being associated with recent igneous rocks, and borates or carbonates of sodium are the principal salts. The fifth class are neutral or alkaline, and consist chiefly of solutions of sulphates and carbonates of sodium, potassium, and calcium. They are often associated with thermal springs. Their composition suggests the possibility that they are mixtures of descending shallow waters and ascending thermal alkaline waters. As already mentioned, the first class are the transporting agents in sulphide enrichment. The second class are the remainders after the first class have lost their metallic salts. The third class occur in mines where there is little or no enrichment. The fourth class, mixing with the first class, produce waters of the fifth class, and the salts of the metals are consequently precipitated. Generally speaking, it may be said that the acidity is greater nearer the surface, and that neutral and alkaline solutions are found at depths. In some mines a decrease in acidity with depth is proved by analyses at various levels. Also it is found that the amount of the salts of the heavy metals decreases with depth, while the amount of alkaline compounds increases. The author concludes by arguing that, as the descending meteoric waters become less concentrated with metallic salts in depth, it is not rational to assume that deep meteoric waters are agents in the formation of primary ore deposits. It will be remembered that James F. Kemp mentioned Mr. Hodge's conclusions, at that time unpublished, in an address which we quoted in our issues of February and March.

Safety with Explosives.—The March issue of the *Journal* of the Chemical Metallurgical & Mining Society of South Africa contains a paper by William Cullen, manager of the Nobel dynamite factory at Modderfontein, analysing the causes of accidents in mines due to misadventures with explosives and blasting. During 1913 there were 251 accidents on the Rand due to explosions, resulting in 223 deaths and 253 injuries. These accidents are classified thus: Drilling into unexploded holes 115, during blasting operations 45, handling detonator 23, fumes 36, during charging 8, during withdrawing 1, others 23. The largest number was in connection with drilling into unexploded charges, and Mr. Cullen makes suggestions for improvements of methods whereby this source of accident may be reduced. We reproduce herewith an outline of his comments. The chief causes for the non-explosion of a charge are: (*a*) neglect of precaution to securely fasten the detonator and fuse to the primer cartridge, (*b*) cut-out shots, (*c*) insensitive explosive, (*d*) bad charging, (*e*) damp detonators. Of all these causes the first is the most important and probably accounts for more accidents than all the rest together. The neglect to take the precaution is a direct violation of clause 106, sub-section 19, of the Government Mining Regulations, which says: "A ganger or miner who is the holder of a blasting certificate shall, in making up a charge, after the fuse with attached detonator has been inserted in the primer cartridge, securely fasten it to the said cartridge so that the fuse and detonator cannot be inadvertently withdrawn." Mr. Cullen holds that in practice the fuse with detonator properly crimped is *not* securely attached to the primer cartridge, in fact not attached at all, but merely stuck in, the regulation being ignored. If the explosives used in the Transvaal were what the Americans call 'straight' dynamite, that is to say, nitro-glycerine absorbed in wood meal, mishaps would occur more frequently, but as the explosives chiefly employed are blasting gelatine and gelignite, which have a gelatinous or sticky consistence, they cling to the detonator, and parting is not so liable to occur.

As regards (*b*), cut-out shots, these can be obviated to a considerable extent by using regular-burning fuses and allowing a longer time-interval between the different shots. No detector devised to indicate cut-out shots has so far proved satisfactory in practice. The third cause (*c*) insensitive explosive, raises a question not fully understood. It is known that gelatinous explosives lose their sensitiveness to the detonator on prolonged storage in tropical or semi-tropical countries, but on the Rand the stocks held are not large so that the explosives should have no opportunity to deteriorate in this way. It occasionally happens, however, that an explosive is insensitive from the start. When charging the hole, it sometimes happens that the series of cartridges are not all in contact. If the explosive is lacking in sensitiveness, the explosion may not bridge the air-gaps, with the result that some of the cartridges are left unexploded. Mr. Cullen recommends the general use of a larger detonator than that at present employed in the Transvaal, so that low sensitiveness may be overcome.

Bad charging (*d*) has already been mentioned under (*c*). Undoubtedly the air-gap must be avoided. Damp

detonators (*e*) are a frequent cause of misfires, and manufacturers insist that detonators shall not be stored in a damp atmosphere. It is best therefore not to keep the detonators below ground too long before use.

Mr. Cullen refers to many other causes of accidents besides those arising from misfires. One of his points is that the proposition to make the bottom cartridge the primer is quite wrong, for the fuse is sure to burn some of the upper cartridges.

Substitutes for Lead Acetate.—On the outbreak of war, the supplies of lead acetate used for coating the zinc shavings employed in the cyanide plant on the Rand ran short. The annual consumption in the Transvaal is about 700 tons per year. Subsequently supplies were obtained from the United States, but at a greatly enhanced price and with undependable delivery. This subject was discussed at the March meeting of the Chemical Metallurgical & Mining Society of South Africa. It was reported on this occasion that W. Cullen had made lead nitrate at the Modderfontein dynamite factory and offered it as a substitute for acetate. The nitrate is a more stable salt than acetate and is rather more soluble in cold water. H. H. White and A. King stated that they had tried the nitrate and found it satisfactory. The relative price of the two salts was the determining factor for the users, and the supply of lead for the local producer of the nitrate.

German Resources.—The *Engineering and Mining Journal* for May 1 and 8 publishes two articles relating to the resources of Germany as affected by the war, the first being a précis of an article by Otto Witt appearing in the *Chemiker Zeitung*, and the second coming from an unnamed correspondent in Germany. Dr. Witt states that the inability to import Spanish pyrite has damaged the chemical industry seriously. When the stock in hand is exhausted, recourse must be had to Norwegian pyrite. Some German pyrite is available, and much could be imported from Hungary and Styria. Probably there are large stocks of Louisiana sulphur at Hamburg. Dr. Witt says that Sicilian sulphur could also be obtained, but this source is now cut-off by the entry of Italy into the war. Attention is drawn to the difficulty of disposing of the chlorine produced in electrolytic alkali manufacture. Since this was written, a use for this undisposable by-product has been found in the trenches. Dr. Witt refers to the inconvenience caused to outside nations by the prohibition of potash exports from Germany, and to Germany by the inability to import phosphates from the United States, Algiers, and from islands in the Pacific ocean. Germany has, however, phosphorus resources in basic slag.

In the second article, reference is made to the invention of substitutes for petrol. Many carbon compounds other than the products obtained by the distillation of coal are being utilized, those higher in carbon being hydrogenated in order to produce substances of similar composition to petrol. The anonymous author gives credit to recent investigators in Germany for this method, but hydrogenation is not a new invention. Reference is made to acetylene for lighting purposes, as a substitute for kerosene, which cannot now be imported from America. Acetylene is obtained commercially by the reaction of water on calcium carbide, so the inference is that carbide is now being used for lighting purposes, and not for the production of ammonia by the cyanamide process. As regards the lack of supplies of Chile nitrate, the anonymous correspondent mentions that the contact process for producing ammonia from the nitrogen of the air and the subsequent conversion of the ammonia into nitric acid will supply all the nitric acid required for the manufacture of explosives. We referred to the Haber ammonia contact process and the Ostwald nitric acid process in our issue of June 1913, when we gave a comprehensive account of the modern methods of fixing atmospheric nitrogen.

The unnamed correspondent states that common cellulose, presumably that derived from wood pulp, can now be used in the preparation of gun-cotton, thereby arguing that any restriction of the import of raw cotton into Germany is having no adverse effect. We would say, however, that this type of explosive prepared from wood pulp, is already used in some of the low-power sporting powders, but that cotton is of far greater value as it can be much further nitrated.

The unnamed correspondent states that sulphuric acid is now being made extensively from barium sulphate. The latter is reduced by coal to barium sulphide, which is decomposed by carbonic acid into barium carbonate, sulphuretted hydrogen being liberated. The sulphur obtainable from the sulphuretted hydrogen is used in the manufacture of sulphuric acid. Thus another alleged source of this acid is indicated, in addition to those named by Dr. Witt. The sulphuric acid obtained from the gases resulting from the roasting of blende is also mentioned.

It is alleged that Germany no longer needs to rely on France for the bauxite used in the manufacture of aluminium, for a Heidelberg chemist has elaborated a process for producing the necessary alumina from common clay. We may mention that A. H. Cowles has already described a process of this nature, as recorded in our issue of October 1912. It is stated that magnesium is to be used instead of aluminium, and that works are being built for the purpose of extracting metallic magnesium from magnesium chloride, a by-product of the potash industry. The magnesium is to be used in an alloy with aluminium. We may add that this is not a new venture, for both magnalium and duralumin are well known, and have certain definite applications.

We give this précis of the two articles, together with our own comments, because the articles have been extensively quoted in other papers without any appreciation of the value or otherwise of the information.

CURRENT LITERATURE

[*Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.*]

Rotary Drills. — A. Beeby Thompson and I. N. Knapp contribute to the May *Bulletin* of the American Institute of Mining Engineers an informing discussion of the causes of failures and methods of avoiding them in drilling with rotaries.

Cost Factors in Coal Production.—In the *Bulletin* of the American Institute of Mining Engineers for May, William H. Grady, of the staff of the U.S. C. & C. Co., presents results of work done at Gary, West Virginia, which bring out in striking fashion the economy that results from concentration of work.

Mining Methods in Arizona.—In the *Engineering and Mining Journal* for May 1, A. N. Penney describes the methods of mining the big lenticular orebodies of the Ray Consolidated copper mine, consisting of shrinkage-stoping with subsequent pillar-caving.

Beach Mining in Alaska.—In the *Engineering and Mining Journal* for May 1, A. G. Thompson describes

the auriferous beach-sands at Yakataga, Alaska, and the method of working them.

Flotation.—The *Mining and Scientific Press* for May 1 contains an article on flotation of copper ores, reference being made to the various oils proposed, notably cresol.

Ore-Dressing. — Butchart riffles are further discussed in the *Bulletin* of the American Institute of Mining Engineers for May, E. P. Mathewson and David Cole giving details as to their use at Anaconda and Cananea. Mr. Cole suggests flow-sheets for copper mills based upon use of disc crushers, Butchart tables, and flotation, greatly reducing capital and operating expenses.

Tin-Dressing. — In the *Engineering and Mining Journal* for May 8, Jesse Simmons describes the tin-dressing plant erected by McNish & Mills at Hill City, South Dakota.

Kennedy Dam. — In the *Mining and Scientific Press* for May 1, J. S. Eastwood describes the dam built for storing stamp-mill tailing at the Kennedy mine, Amador county, California.

Tube-Mills.—The March number of the *Journal* of the Chemical Metallurgical & Mining Society of South Africa contains a paper by W. R. Dowling describing the system of scoop discharge employed on the tube-mills at Knights Deep, Simmer & Jack, and Robinson Deep, with statistics indicating the advantages gained.

Testing Cyanide Solutions.—The *Journal* of the Chemical Metallurgical & Mining Society of South Africa for April contains a paper by Edward H. Croghan on the practical testing of working cyanide solutions, advocating the standardizing of methods of testing, and of recording free cyanide and protective alkali.

United Verde.—In the *Mining and Engineering World* for April 17, C. A. Tupper describes the United Verde copper mine, Arizona, and the new smelting plant at Clarkdale.

Zinc Manufacture in the Pittsburg District.—In *The Iron Age* of May 13 is a concise detailed description of the new Langelotte plant of the American Metal Co. There are 3456 retorts, Hegeler roasting furnaces, and chamber acid works. The whole plant is built along best modern lines.

Tin in Queensland.—In the *Queensland Government Mining Journal* for April, E. C. Saint-Smith describes the alluvial tin-mining operations at China camp, on the Bloomfield river, near the port of Ayton, in the Cooktown district of North Queensland.

Copper Deposits in South Australia.—In the *Mining and Engineering Review* for April, J. Andrew Wauchope describes the Pernatty copper deposits situated 90 miles northwest of Port Augusta, at the head of Spencer gulf, South Australia. The region is arid and the copper minerals, malachite and atacamite, occur in an old lake bed together with other salts.

Pitchblende in Cornwall. — The February-March issue of *Economic Geology* contains a paper by R. A. F. Penrose on pitchblende in Cornwall.

Apex Litigation at Tonopah.—In the *Mining and Scientific Press* for May 15, H. V. Winchell outlines the litigation and judgment in the apex case between Jim Butler and West End companies, Tonopah, Nevada.

Status of the Engineer.—At the April meeting of the South African Institution of Engineers, J. Broad Roberts read a paper on the status of the engineer, civil, mining and mechanical, and electrical, especially with regard to the certificates granted in South Africa.

NEW BOOKS

Mining Costs of the World: A Compilation of Cost and other Important Data on the World's Principal Mines. By E. N. Skinner and H. Robinson Plate. Flexible cover, 406 pages, 7½ by 5 in. New York: McGraw-Hill Book Co. Price 21s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is a most interesting and valuable little pocket-book. It includes carefully sifted data covering operations at about 325 of the more important metal mines of the world. Illustrations are taken from North, South, and Central America, Africa, Asia, Australasia, and Europe, though the greater part of the data refer to the mines of the United States, Mexico, and Canada. It is in just this field that such a compilation has been needed, and the book is accordingly especially welcome. The figures have been taken from company reports, the note-books of the authors, various publications, and in part have been contributed direct by the engineers in charge at the various properties. They are reasonably fresh, and represent in the main the period covered by the years 1909 to 1913 inclusive. In many cases the actual figures are supplemented by brief descriptions of the mines and mining conditions, and in all cases the data have been sifted and checked by the authors, whose wide personal acquaintance with the field make this part of the work especially valuable. Since much of the work of a mine valuer must necessarily be based upon empirical figures, these records of just what it has cost to mine ores in various parts of the world will prove of great service. Incidentally many phases of mining and methods of work are treated. Iron and the non-metallic minerals are not covered, the book being especially devoted to copper, gold, and silver. We hope that it may meet with such success as to warrant the authors preparing many successive editions.

The Cementation of Iron and Steel.—By F. Giolitti; translated by J. W. Richards and C. A. Rouiller. Cloth, octavo, 420 pages, illustrated. New York: McGraw-Hill Book Co. Price 17s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

There is probably no process in the whole range of the metallurgy of iron and steel that has been the subject of more scientific investigation than that of cementation. Since Réaumur published his investigation in 1720-1722, up to the present time, nearly all the leading metallurgists have made it the subject of research. The question to what extent the carbon alone acted as the cementing agent, what part various gases played in the process, and whether cyanides were or were not active agents, have all been the subject of heated controversy for many years, and the results of numerous investigations have been published by all the leading scientific societies in Europe and America. To the student of the subject who wished to investigate for himself all the work that had been done and weigh for himself the evidence for and against the various hypotheses advanced, the difficulties have been hitherto almost insurmountable. The metallurgical world is therefore greatly indebted to the author and translators for placing within the reach of English readers a clear, concise, and critical examination of the numerous researches that have been made on this important and interesting subject.

The work is divided into two parts. The first part deals with the chemistry of cementation and gives a résumé of all important investigations that have been published, from Réaumur's first paper until the

present time. It points out the weakness and strength of the evidence on which the respective contentions are based, in an unpartisan spirit. The second part deals with the industrial application of the process of cementation. To the metallurgical student who wants to obtain a sound grasp of the theory of cementation, the first part of this book is invaluable. He is able to trace how some of the hypotheses advanced have gradually had to be modified in the light of later research, and how by more complete and scientific methods more reliable data have been gradually accumulated, thereby enabling us to arrive at a more accurate knowledge of the facts. References are given to all the researches mentioned, so that the student who wishes to consult the original publications can do so.

The part dealing with industrial cementation processes fully covers the ground from the cementation with solid carbon as practiced at Sheffield to cementation with gases, with fused salts, &c. The different methods of case-hardening are described, the theory and practice fully discussed, and the effect of time and temperature illustrated by curves.

There are useful chapters on the thermal treatment of cemented products and on the methods of controlling the process of cementation, both full of valuable information. The illustrations throughout are excellent. The translators are to be congratulated on the absence of ambiguity from their writing. This work is a valuable addition to metallurgical literature, both to the student and to the practical man.

F. W. HARBORD.

Stamp Milling and Cyaniding. By Francis Andrew Thomson. Cloth, octavo, 285 pages, illustrated. New York: McGraw-Hill Book Co. Price 12s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is an excellent book well adapted to its chief purpose, namely, as a text-book for instruction. It will also, however, be found to be of large value to practising metallurgists, mainly because of the exceptionally good subject bibliographies with which it is complete. It is not only a guide to principles of stamp-milling and cyanidation, but also to the literature of each phase of the subjects. The author is a professor in the State College of Washington, and writes not only from practical experience in designing and operating, but also with a scholarly instinct for that which is best in contemporary writing on the subject. The material is well written and well illustrated, and while the discussion is so brief as to be almost sketchy in places, it is well balanced and unusually free from either error or dogmatism.

Petroleum Industry of California. By R. P. McLaughlin, assisted by C. A. Waring. Cloth, octavo, 519 pages, illustrated, together with atlas of plates. Sacramento, California: State Mining Bureau. Price 12s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The large British interest in California oilfields, with the growing industrial importance of petroleum to the whole world, will make this timely and authoritative report welcome in London as well as locally. Mr. McLaughlin, who prepared the report for the State Mineralogist, is well qualified both by training and practical experience to speak authoritatively upon petroleum, and his knowledge of California is both comprehensive and accurate. He has brought together an unusual amount of detailed information covering the occurrence, production, and marketing of California's most important mineral resource, and it will be a mine of information to engineers having occasion to investigate properties in California or indeed problems relating to petroleum in any part of the world. With the mass of material available, Mr. McLaughlin has had necessarily to treat the subject eclectically, and his choice has been excellent, having in view the object, namely, the preparation of a report for a State upon one of its basal industries. We spoke last month of the unfortunate financial situation into which California petroleum companies had fallen and of difficulties of valuing oil-lands. In this book many illustrations of these embarrassments are presented. We congratutate the author and the Bureau for the frankness and ability with which the situation is presented.

The Chemistry of Petroleum and its Substitutes. By C. K. Tinkler and F. Challenger. Cloth, octavo, 360 pages, illustrated. London: Crosby Lockwood & Son. Price 10s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

Two or three years ago, the University of Birmingham inaugurated a special course of study in connection with petroleum, its geology, mining, and applications, and it is appropriate that this book on the chemistry of petroleum should be prepared by members of the staff of that university. The word 'substitutes' used in the title includes all other organic compounds of similar composition employed not only as substitutes but also for purposes for which the paraffin series are not applicable. The extensive researches now being conducted with the object of converting members of the paraffin series contained in petroleum into compounds belonging to the benzene series, and their subsequent utilization in the manufacture of dyes, explosives, and other highly valuable substances, makes the consideration in one book of the relative chemistry of these groups of compounds extremely valuable to the investigator and student. Until recently the petroleum producers have been content to limit their markets to petrol, oil-fuel, lubricating oil, petroleum jelly, and paraffin wax. A much larger field for their output is now before them, and a knowledge of the chemistry of the substances for which petroleum may yield substitutes or similar compounds is desirable. Moreover, with benzene and alcohol as substitutes for petrol for power purposes, a comparative study of the various compounds from this point of view is necessary.

The first sixty pages of the book are devoted to an outline of the theoretical chemistry of the various series of hydrocarbons, sugars, aldehydes, esters, ketones, fats, nitro-compounds, etc. The next chapter is devoted to the constitution of petroleums found in various parts of the world. Then follow descriptions of distillation methods, and methods for ascertaining the physical characteristics such as boiling and melting points, viscosity, flash-points, etc. An account of the distillation of shales is given, and a chapter is devoted to the cracking of heavy oils. A large section of the book contains information as to the production of hydro-carbons by the distillation of coal and wood, and of alcohols and acids by fermentation. Other sections deal with saponification, thermo-chemistry, relative values of various compounds as fuels, standard specifications, and denaturing. The book is excellently compiled, and the method of presentation attractive. It should certainly be bought by everybody interested in petroleum; and its value to those who are nowadays studying the various opportunities of finding sources of the raw material required in the manufacture of high explosives cannot be over-estimated.

COMPANY REPORTS

Durban Roodepoort.—This company has its office in England and P. A. Molteno is chairman. It is not connected with any of the great houses of the Rand. The original discovery of gold in the Main Reef Series was made on the property belonging to this company. Since the start in 1888, gold worth £4,709,119 has been extracted, and £1,416,333 has been distributed as dividend on a capital of £125,000. The mine is nearing its end. During the year 1914, little new ore has been disclosed, and the reserve on December 31 stood at 475,093 tons, as compared with 630,212 tons the year before. The amount of ore raised was 195,831 tons, and after the removal of 13% waste, 170,238 tons was sent to the mill. The yield by amalgamation and cyanide was worth £176,061, an extraction of 21s. 1d. per ton. The net profit was £36,341, out of which £31,500 was distributed as dividend, being at the rate of 25%. H. Ross Skinner is consulting engineer, and Arnold S. Milne manager.

Durban Roodepoort Deep.—This company owns property in the middle west Rand on the dip of the Durban Roodepoort, and belongs to the Central Mining-Rand Mines group. Milling commenced in 1898 and the first dividend was paid in 1908. Profits have not been on a large scale, and the total dividends to date amount to 55% on a capital of £440,000. The report for the year 1914 shows that 341,771 tons was raised, and after the rejection of 12½% waste, 299,090 tons averaging 28s. 7d. per ton was sent to the mill. The yield by amalgamation was 66,719 oz., and by cyanide 30,355 oz., a total of 97,074 oz., worth £406,765 or 27s. 3d. per ton. The working cost was £349,528, or 23s. 5d. per ton, leaving a working profit of £57,237 or 3s. 10d. per ton. The yield per ton was 1s. 7d. less than in 1913, the working cost per ton 1s. less, and the total profit £7000 less. Out of the profit, £33,000 was distributed as dividend, being at the rate of 7½%. The ore reserve on December 31 was estimated at 928,600 tons averaging 26s. 10d. per ton, together with 374,800 tons in shaft and boundary pillars averaging 30s. 3d. per ton, figures much the same as the year before. Percy Cazalet is consulting engineer, and A. P. Rouillard manager.

New Goch.—This company belongs to the Albu group. It was originally formed as the George Goch in 1887 to acquire claims on the outcrop in the central Rand between the Wolhuter and Nourse. There have been several reconstructions and rearrangements of property, and the only dividends paid were small ones in 1910 and 1911. The report for the year 1914 shows that improved results were obtained, chiefly owing to the reduction of working cost from 16s. 3d. to 14s. 4d. per ton. The amount of ore raised was 403,366 tons, and after the rejection of 10% waste, 359,850 tons averaging 5·4 dwt. gold per ton was sent to the mill. The amount milled in 1913 was 328,350 tons averaging 5 dwt. The yield by amalgamation was 58,995 oz. and by cyanide 28,151 oz., being a total of 87,146 oz. worth £368,095 or 20s. 5d. per ton. In addition gold worth £12,662 was extracted from accumulated slime. The working cost was £259,075, and the working profit £124,580. The directors have decided to employ this profit for the redemption of debentures, of which £112,475 were outstanding on December 31 last. As regards mine development, the main shaft is now down 3406 ft. on the incline, and has nearly reached the southern boundary of the property. During the year, 4701 ft. of development was done, disclosing 279,579 tons of ore. On December 31 the reserve was estimated at 825,896 tons averaging 5·27 dwt. per ton over 84 in. The capital of the company is £550,000.

Geldenhuis Deep.—This company belongs to the Rand Mines group, and was formed in 1893 to acquire property on the dip of the Geldenhuis, in the eastern part of the central Rand. Excellent dividends were paid for many years. In 1909 the part of the outcrop mine remaining unexhausted, together with the Jumpers Deep, were absorbed, but the combined property was not able to supply ore to the 420 stamps, and since that year only 300 stamps have been at work. Moreover, the developments became disappointing in depth, and the profits have been much lower than formerly. The report for the year 1914 shows that 636,496 tons was raised from the mine, and after the removal of 10½% waste, 570,600 tons, averaging 28s. 11d. per ton, was sent to the mill. The yield by amalgamation was 128,780 oz. gold and by cyanide 57,118 oz., a total of 185,898 oz. worth £781,568, being 27s. 5d. per ton. The working cost was £652,471, or 22s. 10d. per ton, leaving a working profit of £129,096, or 4s. 7d. per ton. As compared with the previous year, the tonnage treated was 52,700 tons less, the yield per ton 1s. 8d. per ton less, the working cost 1s. 6d. per ton less, and the total profit £19,808 less. Out of the working profit, £109,828 was distributed as dividend, being at the rate of 18¾%. The ore reserve, including shaft-pillars, on December 31 was estimated at 1,613,000 tons, averaging 26s. 11d. per ton. In the eastern section, development is nearly completed. In the western section, the lower levels have given disappointing results, and the prospects are not encouraging. In consequence it will not be possible during 1915 to maintain the tonnage extracted at the same rate as during the year under review, but probably the divisible profit will not be much lower. E. H. Clifford is consulting engineer, and Edgar Pam manager.

Simmer Deep.—This company was formed in 1906 by the Consolidated Gold Fields of South Africa to amalgamate several properties in the eastern part of the central Rand, on the dip of the Simmer & Jack, and also on the dip of the Rose Deep and Glen Deep, the two last-named being below the Primrose and May mines on the outcrop. Milling commenced in 1908, a plant consisting of 300 stamps being used conjointly with the Jupiter company, 180 being used by the Simmer Deep and 120 by the Jupiter. The Jupiter was shut-down in 1913, under circumstances already recounted in our columns. The capital of the Simmer Deep is £1,650,000, and there are debentures for £835,500 outstanding. No dividends have been paid. The report for the year 1914 shows that the 180 stamps have been fully employed. The ore raised was 655,337 tons, and after the rejection of 1·7% waste, 643,000 tons was sent to the mill. The yield of gold was 127,301 oz., worth £534,062, being an extraction of 16s. 7d. per ton, and the working cost was £495,034, or 15s. 5d. per ton, leaving a working profit of £39,037, or 1s. 2d. per ton. Debenture interest absorbed £48,035, so that no actual profit was made. The ore reserve was estimated on December 31 at 1,429,000 tons averaging 4·3 dwt. per ton, and 302,000 tons is reported as partly developed, of an indicated assay-value of 4·6 dwt. per ton. These figures are slightly better than those of a year ago. The future development is to be confined to the more promising sections, for the experience so far shows that the treatment of average ore is not likely to meet expenses and debenture interest.

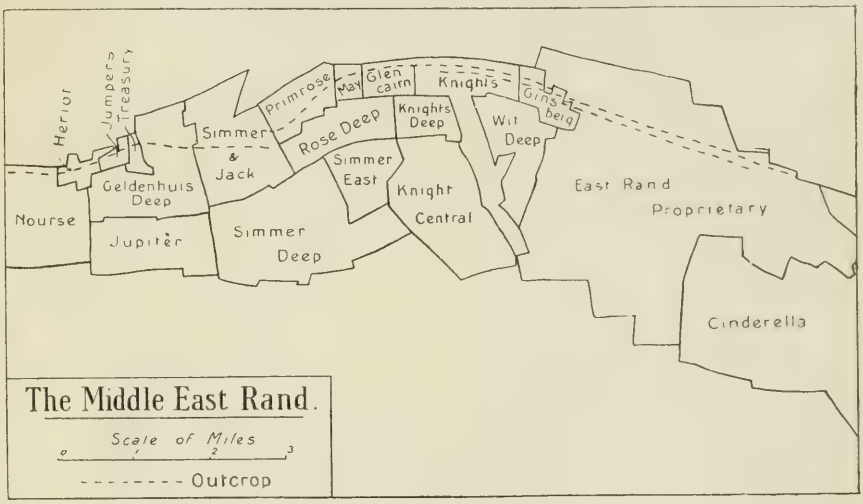
Knight Central.—This company belongs to the Neumann group, and was formed in 1895 to acquire a

'second-deep,' below the Knights Deep in the middle east Rand. Milling started in 1909, and a first and only dividend was paid for 1910. At depths of 3997 ft. and 4330 ft. respectively the west and east shafts intersected the great Simmer dike. Cross-cuts through the dike from the 13th and 14th levels on the west shaft and from the 15th and 16th levels on the east shaft proved the dike to average 375 ft. in thickness, and showed that the reefs were 620 ft. nearer the surface on the south of the dike than to the north. The development of the southern part has been effected by auxiliary incline shafts. Unfortunately the results have been disappointing. The report for the year 1914 shows that altogether 5280 ft. of development below the dike has been sampled, and that the average assay-value is only 2·7 dwt. gold per ton over an average width of 56 in. The patches of higher-grade ore are so small and disconnected that they could not be mined profitably. During the year, 293,199 tons of ore was raised, and 284,960 tons averaging 5·53 dwt. gold per ton sent to the mill. The yield of gold was worth £316,079 or 22s. 2d. per ton milled, and the working cost £273,326 or 19s. 2d. per ton, leaving a working profit of £42,752 or 3s. per ton. Out of the profit, £31,999 has been allocated to capital expenditure, chiefly for shaft-sinking. The ore reserve, all above the dike, was estimated on December 31 at 430,500 tons, averaging 5·7 dwt. over 63 in., a fall of 108,600 tons and 0·3 dwt. as compared with the year before. There is little ground left to be explored above the dike, and efforts will be made to continue development in depth.

Witwatersrand Gold.—This company owns the mine usually known as Knight's, on the outcrop in the middle east Rand. The control is with the Barnato group, and F. B. Lewis is manager. Milling commenced in 1888, but was suspended from 1891 to 1896 pending further exploration. In 1910 it was decided to develop the deep-level section, and a vertical shaft was sunk for this purpose, 3000 ft. south of the outcrop. The report for the year 1914 shows that the excellent results recorded a year ago have been fully maintained. The amount of ore raised was 601,294 tons, of which 310,928 tons was obtained by stoping and 277,733 tons from reclamation. After the removal of 16% waste, 503,350 tons averaging 6 dwt. was sent to the mill. The yield of gold by amalgamation and cyanide was 143,241 oz. worth £608,965, being an extraction of 5·7 dwt. or 24s. 2d. per ton milled. The working cost was £337,942 or 13s. 4d. per ton, leaving a working profit of £271,023 or 10s. 10d. per ton. The shareholders received £234,812, the dividend being at the rate of 50%. The reserve has been maintained, at 1,221,879 milling tons estimated to have a recovery-value of 6·6 dwt. per ton. A large amount of low-grade ore remains in the foot-wall in the upper levels not reckoned in the reserve. This will be gradually reclaimed and treated together with the reserve ore. The development in the southern section has been satisfactory, the results to the north of the vertical shaft being particularly encouraging.

Witwatersrand Deep.—This company was formed in 1895 to acquire a deep-level property in the middle east Rand, below the Ginsberg and west of the East Rand Proprietary. The control is with the Neumann group, David Wilkinson is consulting engineer, and E. E. Hardach is manager. Milling started in 1902, and the first dividend was paid in 1906. The plant now contains 245 stamps and 4 tube-mills. The report for the year 1914 shows that the ore developed and mined in the section below the 'water' dike is not of as high a grade as that above. During the year, 435,457 tons of ore was extracted from the stopes, 120,773 tons obtained by reclamation, and 18,953 tons of development ore raised, the total being 575,183 tons. After the rejection of 10% waste, 518,409 tons was sent to the mill. The yield by amalgamation was worth £502,048, and by cyanide £175,505, a total of £677,554, or 26s. 2d per ton. The working cost was £426,386, or 16s. 5d. per ton, leaving a working profit of £251,168, or 9s. 9d. per ton. Out of the profit, £38,181 was devoted to capital expenditure on plant and shaft-sinking. The shareholders received £178,750, the dividend being at the rate of 32½%. For 1913, the yield per ton was 28s. 11d., so that the figure for 1914 was 2s. 10d. lower. As a consequence, the total working profit was £52,060 less. The ore reserve was estimated on December 31 at 1,707,400 tons, averaging 6·2 dwt., an increase of 41,400 tons during the year, but a fall in the average assay-value of 0·6 dwt. per ton.

Antelope.—This company was formed in 1908 to acquire a gold-mining property in the West Gwanda district of Rhodesia, situated about 60 miles south of



Bulawayo. The control passed in 1912 from the Rhodesian Exploration & Development Co. to the Gold Fields Rhodesian Development Co. H. A. Piper and W. F. H. Dudgeon are the consulting engineers. The ore comes from banded ironstone and is pyritic, so that roasting is necessary. The report for the year 1914 shows that the metallurgical plant started in November 1913, but that several alterations had to be made subsequently. The amount of ore treated was 40,866 tons, averaging 12·2 dwt. per ton, and the yield was 22,592 oz., or 11 dwt. per ton. The income from the sale of gold was £95,515, and the working cost was £62,671 or 30s. 8d. per ton. The profit has been devoted to the repayment of the loan advanced by the Gold Fields Rhodesian Development Co., and of the total advanced, £60,000, one-half has been thus repayed. The issued share capital remains at £348,282. The ore reserve on December 31 last was estimated at 134,497 tons, averaging 9·6 dwt. per ton. Development during the year was confined to the 12th level, and the results were disappointing. At the time when the consulting engineers' report was written, a rich shoot had been struck, and the 20 ft. driven on it was reported to average 34 dwt. over 107 in. No further information was given at the meeting of shareholders.

Waihi Gold.—This company was formed in 1887 to acquire gold-mining properties in the Thames district of the northern island of New Zealand. Dividends were first paid in 1893, and they continued on an increasingly handsome scale until 1910, when the lodes became impoverished in depth, and the rate of output and profit fell in a marked manner. From the commencement the total yield has been worth £10,787,038, and £4,577,720 has been paid as dividends. The report for the year 1914 shows that 183,405 tons was sent to the mills, and that gold and silver worth £332,165 was extracted. The yield per ton was 31s. 2d. gold and 4s. 7d. silver. The working profit was £145,016, out of which the shareholders received £99,181, being 20% on the capital. These results are about the same as during 1913. During 1909, the yield was worth £959,594, and £446,316 was distributed as dividend, at the rate of 90%. Development has been continued on the 11th level in the Dreadnought, Empire, and Martha lodes, but there is no improvement in the character of the ore disclosed. It is intended to sink only two of the four shafts below the 11th level, and these operations will be started when new electric pumps are delivered. The ore reserve on December 31 was estimated at 753,358 tons of unspecified assay-value. The tonnage is about the same as a year ago. In addition 697,547 tons is estimated to be in the arches and pillars. The Hora Hora hydro-electric plant was completed in the early part of 1914, and the whole of the power for the mine and mills is now obtained from this source. The cost has been substantially reduced thereby.

Waihi Grand Junction.—This company was formed in 1895 to acquire gold-mining properties adjoining the Waihi mine in the northern island of New Zealand. The lodes worked are the continuations in a north-easterly direction of the Martha, Empire, and Royal lodes. Owing to the conformation of the country, the 5th level on the Grand Junction corresponds approximately to the 9th on the Waihi, but as the original outcrops of the rocks containing the lodes are at a much lower level in the Grand Junction than the Waihi, the zone of impoverishment has not yet been reached at the Grand Junction. Milling started in 1906 with 40 stamps, and 10 tube-mills have since been added. The equipment includes 60 more stamps, but these were not erected at the time of delivery, and it is only recently that twenty of them were brought into use. The early history of the company was far from satisfactory, and the manager, F. C. Brown, though an inventor of note in connection with slime-agitation, did not make the mine pay. W. F. Grace was appointed as manager in 1909. During 1912 and 1913 the labour troubles in New Zealand seriously affected the output, and after the strike it was difficult to collect an efficient mining staff again. The report for the year 1914 shows that 115,720 tons of ore, averaging 9·2 dwt. gold and 2 oz. silver per ton, was treated, for a yield of gold and silver worth £227,636, comparing with 98,383 tons and £184,888 the year before. The net profit, after full allowance for depreciation, was £76,636, out of which £15,000 was placed to reserve, and £57,656 was distributed as dividend, at the rate of 15%. The percentage of recovery was increased from 90 to 92% gold and from 74 to 79% silver. The ore reserve on December 31 was estimated at 173,000 tons, 2100 tons less than the year before, the fall being due to temporary flooding. Development on the 7th or lowest level has given good results on the Empire lode and the western drift on the Royal lode. The eastern drift on the Royal, and the lodes to the north of the shaft have given disappointing results. The shaft is to be sunk and an 8th level opened. The additional 20 stamps have been brought into commission, and the old stamps have been hung-up ten at a time for repairs to the framework.

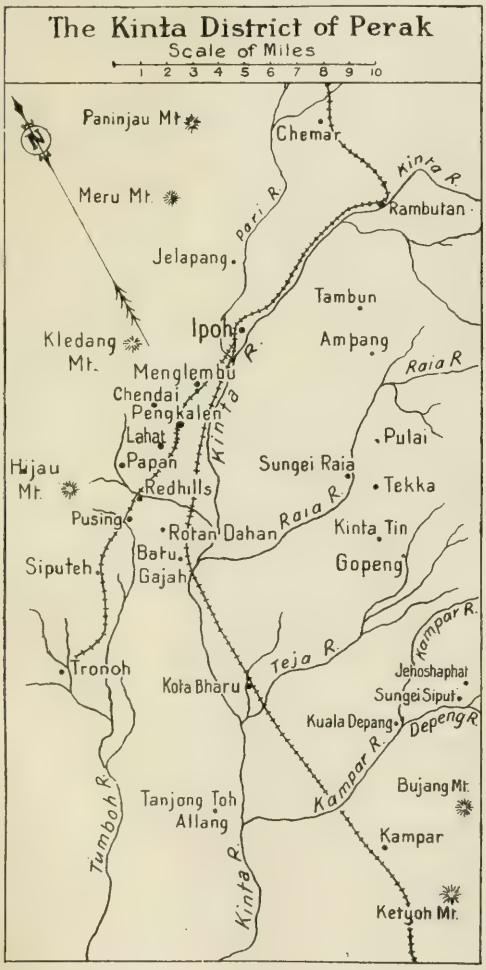
Gopeng Consolidated.—This company was formed in September 1912 as an amalgamation of the Gopeng and the New Gopeng, two companies under the control of James Wickett, of Redruth, that had for some years been successfully treating tin gravel on the eastern side of Kinta valley, Perak, Federated Malay States. The consolidation was arranged in order to facilitate the financing of a plan for providing additional water-supply conjointly with the Kinta Tin company. Osborne & Chappel are the managers. The report for the year ended September 30 shows that 444 tons of tin concentrate was produced, which sold for £41,358. The amount was 9 tons less than during the previous year, and owing to the fall in the price of tin the receipts were £14,945 less. At the Ulu Gopeng property, which the company works for the Berwick Estate, the output was 52¾ tons, and the profit accruing to the company £1018. The rubber plantations yielded an income of £1748. The total profit of the company for the year was £28,694, out of which £22,541 has been paid as dividend, being at the rate of 6¼ per cent. The new pipe-line has been completed since the end of the period covered by the report, and the production may be expected to increase substantially within a month or two.

Tekka.—This company was formed in 1907 by James Wickett, with headquarters at Redruth, to acquire the Sungei Raia alluvial-tin property in the Kinta district of Perak, Federated Malay States. Osborne & Chappel are the managers. Substantial dividends have been paid regularly. The report for the year ended January 31 shows that 473,100 cu. yd. of gravel was treated for a yield of 491½ tons of tin concentrate, selling for £40,586. The yield per yard was 2⅛ lb., and the cost per yard 7·94d. The output was 133½ tons higher than the year before, but, owing to the low price of tin after the outbreak of the war, the increase in the revenue was only £1669. The net profit was £25,264, out of which £24,000 was distributed as dividend, being at the rate of 30 per cent.

Tekka - Taiping.—This company is a subsidiary of the Tekka, and was formed in 1913 to work the Taip-

ing property, Perak, Federated Malay States. The report for the year ended October 31 last shows that the earlier weeks were occupied in repairing the damage done to the suction-dredge by a land-slide. After the resumption of operations, to the end of the period under review, 198 tons of tin concentrate was recovered from 322,200 cu. yd. of gravel, and the income from its sale was £16,297. The net profit was £1400. A new bucket-dredge, made by Werf Conrad, was delivered at the mine in December, and this will supersede the suction-dredge.

Pengkalen.—This company was formed in 1907 by James Wickett, of Redruth, to acquire a tin-gravel property at Lahat, in the State of Perak, Federated



Malay States. Osborne & Chappel are the managers. Though a comparatively large producer, the mine has not proved generally profitable owing to high costs. In October last, the difficulty of selling tin concentrate and the low price of the metal made it necessary to suspend operations. The report for the year ended September 30 shows that three dredges (of the floating-barge or suction type) were at work, and that the output of tin concentrate was 283 tons obtained from 585,180 cu. yd. The income from the sale of concentrate was £26,315 and the mining cost £32,467. The sale of power brought an income of £3003. The accounts show a loss of £3570. A resumption of operations is contemplated.

Tronoh Mines.—This company was formed in 1901 to acquire alluvial-tin properties in the Kinta district of Perak, Federated Malay States. At the time of formation the office was at Redruth. Gilbert B. Pearce was chairman and James Wickett secretary, Frederick Wickett mine manager, and F. Douglas Osborne general and financial manager. The actual control was left in the hands of the original vendors, E. G. Edgar and Foo Choo Choon. After half-a-dozen years of prosperity, the methods of mining had to be changed. The English board took control, the office was moved to London, and H. D. Griffiths was appointed manager. Another series of profitable years then ensued. Two years ago, however, the richer gravels showed signs of exhaustion, and alternative methods of treatment had to be introduced. The report for the year 1914 shows that a serious land-slide interfered with the treatment at the chief open-cut, necessitating the removal of much overburden before the tin-alluvium could be reached once more. Thus the amount of tin recovered was less than would otherwise have been the case. The installation of the bucket-dredge at No. 5 mine was not completed before the end of the year. The dredge originally erected for the purpose of re-treating tailing has been moved to virgin ground and should be at work shortly. The total production of tin concentrate during the year was 1539 tons, obtained from 442,394 cubic yards of gravel, as compared with 2187 tons from 577,930 cu. yd. in 1913, and 2776 tons from 496,495 cu. yd. in 1912. Half the yield of concentrate was won by tributors, from one-fifth of the total gravel treated. The revenue from the sale of concentrate was £139,015, as compared with £268,001 in 1913, and £349,334 in 1912. The average price per ton of concentrate was £90, as compared with £123 for 1913. The price of tin had fallen before the war, and subsequently the conditions became worse, as concentrate was unsaleable during August and September. The Federated Malay States advanced money on the production, at the rate of £70 per ton of concentrate, in order that operations should be continued, especially for the protection of the native population. The accounts show a loss of £20,109 on the year's working. For 1913 a dividend of 37½% was paid, and for 1912 one of 75%, on a capital of £160,000.

Ouro Preto Gold Mines of Brazil.—This company was formed by John Taylor & Sons in 1884 to acquire the Passagem gold mine in the State of Minas Geraes, Brazil. The mine is near the Morro Velho, belonging to the St. John del Rey company, and is on the same formation. The grade of the ore is, however, lower. Small dividends were paid on the ordinary shares in 1895, 1896, 1902, 1908, 1910, and 1911. Reconstruction was necessary in 1893, and a second reconstruction was effected in July 1914. On the latter occasion, the £100,000 ordinary shares were scaled down to £15,000, and the £36,634 preference shares were converted into £12,212 preference and £24,424 ordinary shares. It was intended concurrently to issue 30,000 new preference shares of £1 each in order to push development and provide extra plant necessary for an increased output. Owing to adverse financial conditions, the new capital issue has been postponed. The report for the year 1914 shows that 80,138 metric tons of ore was treated, an increase of 14,000 tons as compared with 1913, and that 27,085 oz. of gold was recovered worth £114,569, being a yield of 28s. 7d. per ton, an increase of £24,136, or 1s. 4d. per ton. After the payment of a

dividend on the 10% preference shares for the period from July 15 to December 31, absorbing £565, a balance of profit remained of £980, which was carried forward. The reserve was estimated on December 31 at 112,678 tons, a figure much the same as that of a year ago.

Hutti (Nizam's) Gold Mines.—This company was formed in 1901 to acquire the Hutti gold mines in the state of Hyderabad, Central India, from the Hyderabad (Deccan) company. F. W. Grey is chairman, Thomas Morgans is a director, and J. Douglas Hay is manager. Milling was started in 1903 with 10 stamps; subsequently 20 more stamps were added, and more recently cyanide and slime plant. Dividends totalling 90% on a capital of £69,610 were paid from 1903 to 1910, but in the latter year the workings, from the 1440-ft. to the 1740-ft. level, were in ore of low grade, and no profit was made in 1911. A richer zone was found from 1740 ft. to 2240 ft., and dividends were paid in 1912, 1913, and 1914. At the 2460-ft. level the ore is again of lower grade, but the latest news, as recorded in our issue of last month, is that rich ore has once again been found. The report for the year 1914 shows that 33,425 tons of ore was treated for a yield of gold worth £80,555. The amount was 7250 tons higher than during the previous year, and the yield £3214 greater, but, owing to the ore drawn from the 2340-ft. and 2460-ft. levels being of lower grade, the yield per ton was only 12½ dwt. as compared with 14¾ dwt. The working profit was £25,492, and, after allowance for depreciation, the net balance was £11,088. Out of this, £9783 has been paid as dividend, being 15% less income tax. The ore reserve, not including pillars, was estimated on December 31 at 64,000 tons, averaging 10¼ dwt. per ton. The long distance, 52 miles, from railway communication still acts adversely as regards costs. The slime plant is reported to be giving disappointing results so far, but improvements are expected. The main shaft is down to 2645 ft., and a level is to be opened at 2660 feet.

British Broken Hill.—This company was formed in 1887 to purchase Blocks 15 and 16 from the Broken Hill Proprietary. The property has not been one of the most successful of the Broken Hill group of silver-lead-zinc mines. The original nominal capital has been scaled down, and on two occasions additional capital has been raised. Twice the mine has been closed during periods of depressed metal prices. Of recent events, the most important have been the discovery of a new lode in 1912, and the closing of the mine, for the third time, on the outbreak of the war. The report for the half-year ended December 31 last shows that during the 36 days of operation, 28,512 tons of ore was raised, averaging 12·8% lead, 11·5% zinc, and 7·1 oz. silver per ton. In the concentrator, 4277 tons of lead concentrate was produced averaging 63% lead, and 26 oz. silver per ton; and in the flotation plant there was produced 4280 tons of zinc concentrate averaging 41·3% zinc, 10·9% lead, and 11·7 oz. silver. The accounts show an income of £29,328 from the sale of lead and zinc concentrates, and a loss on the half-year's working of £17,610. The ore reserve is estimated at 1,053,250 tons averaging 13% lead, 11·1% zinc, and 6·6 oz. silver.

Amalgamated Zinc (De Bavay's).—This company is registered in Melbourne and operates the De Bavay flotation process, treating the zinc tailing produced at the North, South, and Block 10 mines at Broken Hill. It also holds shares in the Minerals Separation & De Bavay's Processes Australia Proprietary Limited, a company formed to pool the royalties accruing from the use of the two processes in Australia. W. L. Baillieu is chairman, and H. W. Gepp is manager. The report for the half-year ended December 31 shows that after the declaration of war the plant ran alternate weeks, and was in operation altogether for 17 weeks. During this time, 165,438 tons of zinc tailing was treated, and the yield was 45,286 tons of zinc concentrate averaging 48·7% zinc, 6·2% lead, and 9 oz. silver per ton, together with 368 tons of lead concentrate averaging 55·8% lead, 15·2% zinc, and 43·6 oz. silver. The lead concentrate has been sold, but the zinc concentrate remains in stock. Mr. Gepp has recently been in the United States with the object of finding a market for it there. In the accounts, the zinc concentrate is entered as worth £90,687, the price of the metal being taken at £21 per ton. The balance to the credit of profit and loss, on this basis, stands at £34,356.

Basset Mines.—This company was formed under limited liability in 1896 to acquire the Basset and South Frances tin mines, situated a few miles south of Redruth, Cornwall. Francis Oats, so long connected with the De Beers diamond mines, is chairman. The capital is £120,000, consisting of several different denominations of shares. The only dividends paid have been 15% and 7½% on the 35,500 preference shares in 1911 and 1912. The report for the year 1914 shows a serious loss, owing partly to the smaller amount of ore raised, and partly to the fall in the price of tin. The ore raised totalled 40,837 tons, as compared with 51,087 tons during 1913, and the concentrate recovered was 497 tons as compared with 574 tons. The average price obtained for the concentrate was £82. 18s. 2d. per ton, as compared with £117. 16s., and the total receipts were £42,652, as compared with £67,695. The working cost was £56,798, so that the loss on the year's working was £14,145. It has been necessary also to write-off £4196 for depreciation on the investments constituting the reserve fund. The results of development during the year have been discouraging. The West Frances lodes and the West Basset lodes contain little ore below 1800 ft. in depth. In the central and eastern sections, the chances are more favourable, but the manager, William James, is not too hopeful.

Ducktown Sulphur Copper & Iron.—This company was formed in London in 1891 to acquire copper properties at Ducktown, Tennessee, U.S.A., not far from the mines of the Tennessee Copper Co. J. G. Gordon is chairman and managing director. A sulphuric acid plant was started in 1910 with the object of saving the acid driven off in roasting. The report for the year 1914 shows that 2616 tons of fine copper was produced from 169,000 tons of ore, and that 45,770 tons of sulphuric acid was made. The accounts are not given in detail. The ordinary shareholders received £15,984, the dividend being at the rate of 8%, and the holders of founders' shares received £1998. The capital of the company is £199,800 in ordinary shares and £200 in founders' shares. The ordinary shares are entitled to 7% dividend and one half of the remaining profits, and the founders' shares receive the other half. W. Y. Westervelt, the consulting engineer, reports an increase in the reserve during the year at the Mary mine, the chief producer, the figure now standing at 700,000 tons averaging 2% copper and 15% sulphur. At the East Tennessee mine, the remaining reserve is estimated at 40,000 tons averaging 2½% copper and 8% sulphur, with indications that this amount may be exceeded. At the Isabella mine, the reserve remains at 2,500,000 tons averaging 0·8% copper and 29% sulphur.

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